Brent Wiley, Editor
James D. Kelly, Advertising Mgr.

BOARD OF DIRECTORS

1936 • 1937

▲

PRESIDENT,
H. G. R. BENNETT,
Assistant
General Superintendent,
Carnegie-Illinois Steel
Corporation,
Duquesne, Pa.

1ST VICE PRESIDENT, L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

2ND VICE PRESIDENT, C. C. WALES, Chief Engineer, Otis Steel Co., Cleveland, Ohio.

DIRECTOR AT LARGE, C. L. McGRANAHAN, Assistant General Superintendent, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

HONORARY DIRECTOR, JAS. FARRINGTON, Electrical Superintendent, Wheeling Steel Corp., Steubenville, Ohio.

HONORARY DIRECTOR, E. FRIEDLANDER, Pittsburgh, Pa.

PAST PRESIDENT, G. R. CARROLL, Electrical Superintendent, Jones & Laughlin Steel Corp., Aliquippa, Pa.

PAST PRESIDENT, W. H. BURR, Electrical Superintendent, Lukens Steel Co., Coatesville, Pa.

TREASURER, F. E. FLYNN, Gen. Mgr., Warren District, Republic Steel Corp., Warren, Ohio.

SECRETARY, J. L. MILLER, Assistant Combustion Engineer, Republic Steel Corp., Cleveland, Ohio.

DIRECTOR, J. W. BATES, Electrical Engineer, Power Division, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

DIRECTOR, C. G. PECU, Lubrication Engineer, Bethlehem Steel Co., Lackawanna, N. Y.

DIRECTOR, M. J. CONWAY, Fuel Engineer, Lukens Steel Co., Coatesville, Pa.

DIRECTOR, J. A. CLAUSS, Chief Engineer, Great Lakes Steel Corp., Ecorse, Mich.

DIRECTOR, H. G. HAGUE, Electrical Superintendent, Carnegie-Illinois Steel Corp., Gary Sheet Mill, Gary, Indiana.

DIRECTOR, G. N. HUGHES, Alabama City, Ala.

DIRECTOR, F. E. LEAHY, Fuel Engineer, Youngstown Sheet & Tube Co., Youngstown, Ohio.

DIRECTOR, W. A. PERRY, Superintendent, Electrical and Power Departments, Inland Steel Company, Indiana Harbor, Ind.

DIRECTOR, R. G. ADAIR, Asst. Director of Industrial and Public Relations, American Rolling Mill Co., Middletown, Ohio.

▲

MANAGING DIRECTOR
BRENT WILEY
Empire Building, Pittsburgh, Pa.

IRON AND STEEL ENGINEER

VOL. XIV AUGUST • 1937 NO. VIII

CONTENTS

Individual Motor Drives on Wide Strip Mills—by F. E. Harrell, Assistant Chief Engineer, and W. R. Hough, Experimental Engineer, Reliance Electric & Engineering Company, Cleveland, Ohio 23

Diesel Electric Locomotives in Steel Mill Service—by F. H. Craton, Transportation Department, General Electric Company, Erie, Penna. 31

DISCUSSION—Diesel Electric Locomotives in Steel Mill Service—Presented by W. A. Marshall, Engineer, Carnegie-Illinois Steel Corporation, Irvin Works, Dravosburg, Penna.; O. Needham, Engineer, Westinghouse Electric & Manufacturing Company, Pittsburgh, Penna.; C. C. Bailey, Transportation Department, General Electric Company, Schenectady, New York; A. J. Standing, Electrical Superintendent, Bethlehem Steel Company, Bethlehem, Penna. and F. H. Craton, Transportation Department, General Electric Company, Erie, Penna. 37

Modern Steam Turbines in Steel Mills—by A. G. Darling, Industrial Department, General Electric Company, Schenectady, New York 39

Latest Design and Equipment For The Industry 49

Items of Interest 53

Association Activities 6

Prizes—Iron and Steel Exposition 8

Index to Advertisers 10

Tentative Program—Thirty-third Convention, Association of Iron and Steel Engineers 20–21

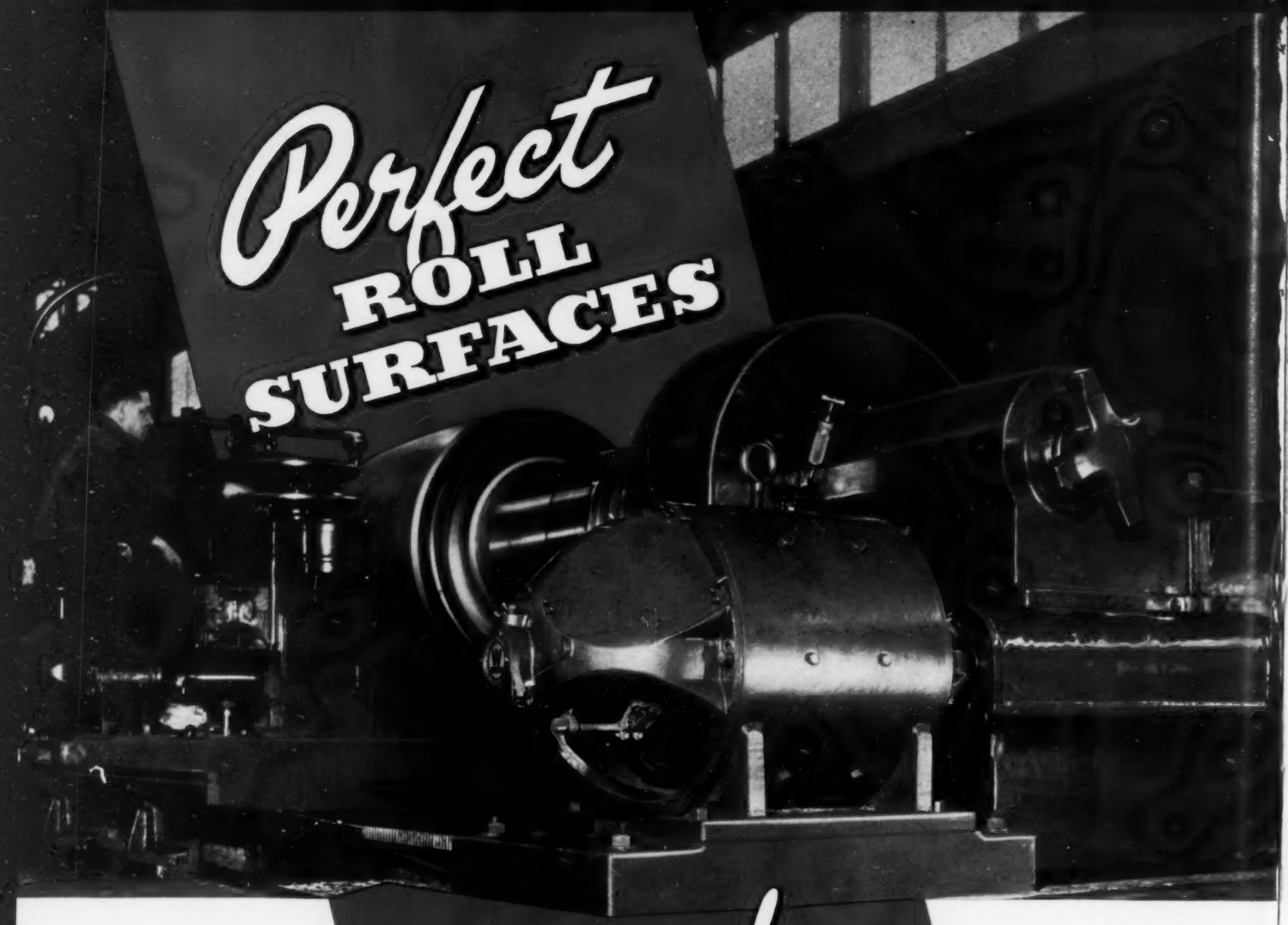
Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS

Entered as second-class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879. Single Copy $1 00
Subscription price in U. S. & Canada ..... $5.00 per year
Subscription price in foreign countries ..... $7.50 per year

PLASTIC BINDING U. S. PATENT NO. 1970205 LICENSE NO. 11

Perfect ROLL SURFACES



Above—Four Westinghouse Motors, with specialized control, power this roll grinder. A 40-hp., 600 to 1200-rpm. motor drives the grinding wheel; a 7½-hp., 150 to 1200-rpm. motor drives the head stock; a 5-hp. motor drives the carriage feed; and a 2-hp. motor drives the cross feed. Motors of special design make possible the 8 to 1 speed range of the head stock motor with field control only and the smooth application of power to the grinding wheel, which results in a better finish of rolls and roll necks.

demand SPECIAL GRINDER MOTORS MATCHED WITH SPECIALIZED CONTROL

Below—Mesta Roll Grinder equipped with Westinghouse Motors and Control.

PERFECT grinding of mill rolls necessitates absolutely smooth application of power, both to the roll and the grinding wheel. To obtain this smooth power, Westinghouse roll grinder motors have special design features that eliminate any tendency toward wheel chatter. Added to these design features is a degree of dynamic balance of the rotor to meet the most rigid specifications.

Control requirements, too, are exacting. Heavy duty steel mill type control, tailored to the requirements of the machine, places at the operator's finger-tips complete and accurate control of all operations and speeds.

The complete steel mill electrical service offered by Westinghouse includes motors, control, and other equipment matched to today's rigid requirements. Call your nearest Westinghouse office for complete information, and for engineering assistance available to you in the application of this equipment.

Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa.

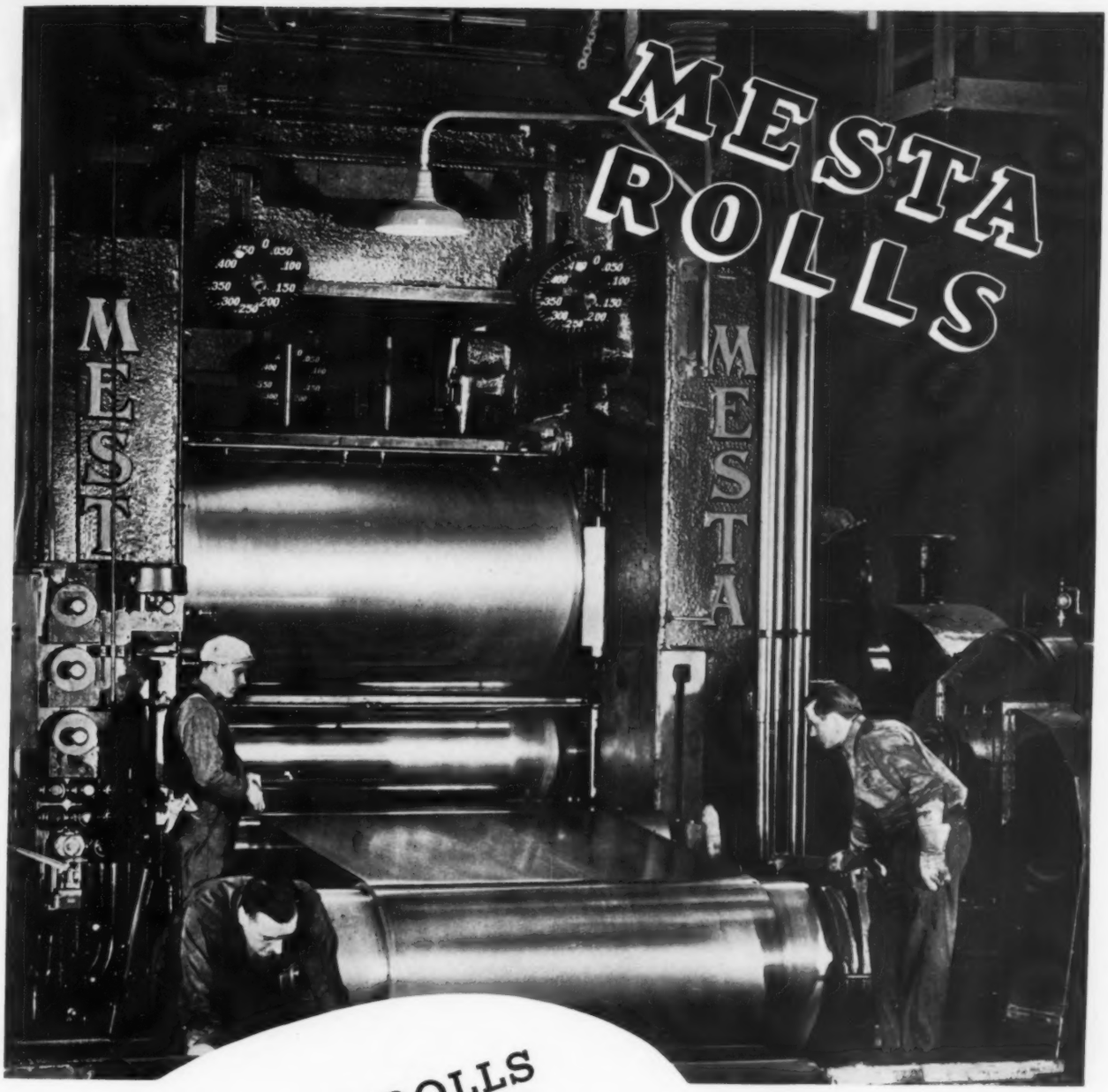
J 93251

UNDIVIDED RESPONSIBILITY MULTIPLIES THE VALUE of WESTINGHOUSE SERVICE

FROM POWER SUPPLY TO DRIVEN MACHINE

Specify **Westinghouse**

W WESTINGHOUSE ELECTRIC



WORKING ROLLS
and
BACKING-UP ROLLS
for
FOUR HIGH CONTINUOUS
COLD STRIP MILLS

MESTA MACHINE COMPANY - PITTSBURGH

TIME

IS GROWING SHORT . . .

for your company to make its reservation for space in the **Iron & Steel Exposition** to be held in the Stevens Hotel, Chicago, Ill., **September 28, 29, 30, and October 1.** The most representative steel mill equipment companies have already reserved over 90 per cent of the space. Sponsored and controlled by the Association of Iron & Steel Engineers you will be assured of a quality attendance: Write, wire, or phone—The Iron & Steel Exposition, 1010 Empire Bldg., Pittsburgh, Pa.

Stevens Hotel will house all of the activities relating to the annual convention and Iron and Steel Exposition.

IRON & STEEL EXPOSITION

STEVENS HOTEL, CHICAGO, ILL., SEPTEMBER 28, 29, 30, AND OCTOBER 1, 1937

3 Very Vital Savings

•USE• BILLETEERS AND Save

•MEN •MONEY •MATERIAL•

Time tested—by years of hard service in leading plants the improved BILLETEER will yield amazing returns in the chipping of billets and blooms.

•

No management—in this uncertain age—will sanction delay in searching the facts on this timely equipment unit.

•

Troublesome chipping conditions can be—should be—will be—simplified by using BILLETEERS.

Men saved for other less gruelling jobs—on a ratio of at least 10 to 1—thus extending their usefulness—and improving morale.

•

Money saved in chipping costs because of the smoothe, rapid way this machine responds—in spot chipping or skinning—all classes of steel.

•

Materials saved by wasteless cleaning and because amazing chipping speed eliminates remelting costs and losses.

TO WHOM SHALL WE SUBMIT THE BILLETEER STORY?

Also latest data on crushing, pulverizing and mixing equipment.

STEEL EQUIPMENT DIVISION

THE BONNOT CO. Canton, Ohio

ADVERTISING PAGES REMOVED

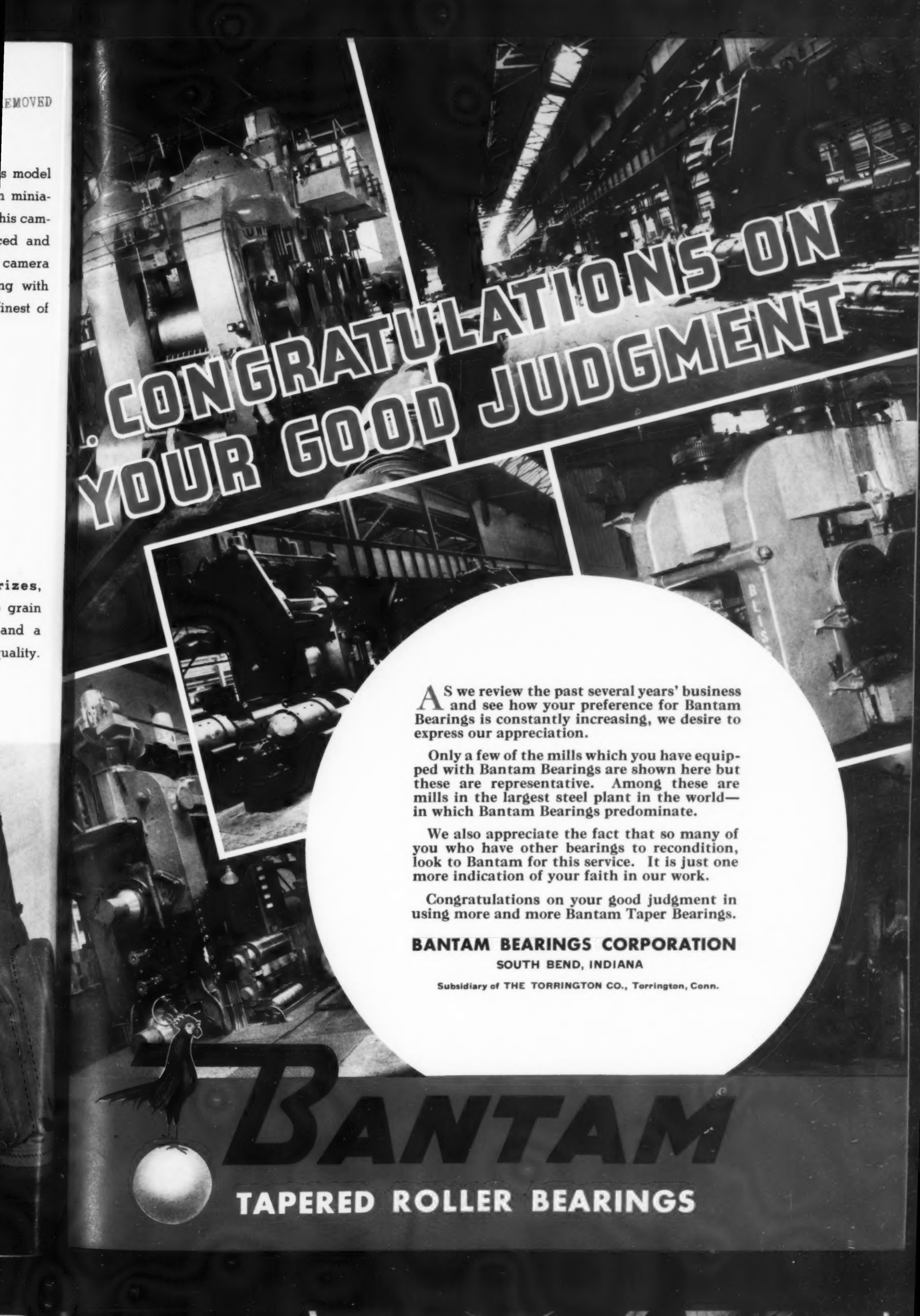
First prize will be this model G Leica, the ultimate in miniature cameras. Briefly, this camera is the most advanced and desirable in the entire camera field and has everything with which to produce the finest of photographs.

▲

Second and **third prizes**, shown below, are a top grain leather Gladstone bag and a golf bag of excellent quality.

Steel Men

win one of the $500.00 worth of prizes which will be awarded at the coming Iron and Steel Exposition, Stevens Hotel, September 28, 29, 30 and October 1. First prize will be a model G Leica camera. Second and third prizes are a traveling bag and a golf bag. There will be ten other prizes valued at $20.00 each. Details on how to win one of these prizes will be furnished at the convention registration desk, Stevens Hotel. Only operating and executive personnel in the industry may compete for these awards.



AS we review the past several years' business and see how your preference for Bantam Bearings is constantly increasing, we desire to express our appreciation.

Only a few of the mills which you have equipped with Bantam Bearings are shown here but these are representative. Among these are mills in the largest steel plant in the world—in which Bantam Bearings predominate.

We also appreciate the fact that so many of you who have other bearings to recondition, look to Bantam for this service. It is just one more indication of your faith in our work.

Congratulations on your good judgment in using more and more Bantam Taper Bearings.

BANTAM BEARINGS CORPORATION

SOUTH BEND, INDIANA

Subsidiary of THE TORRINGTON CO., Torrington, Conn.

BANTAM

TAPERED ROLLER BEARINGS

ADVERTISING PAGES REMOVED

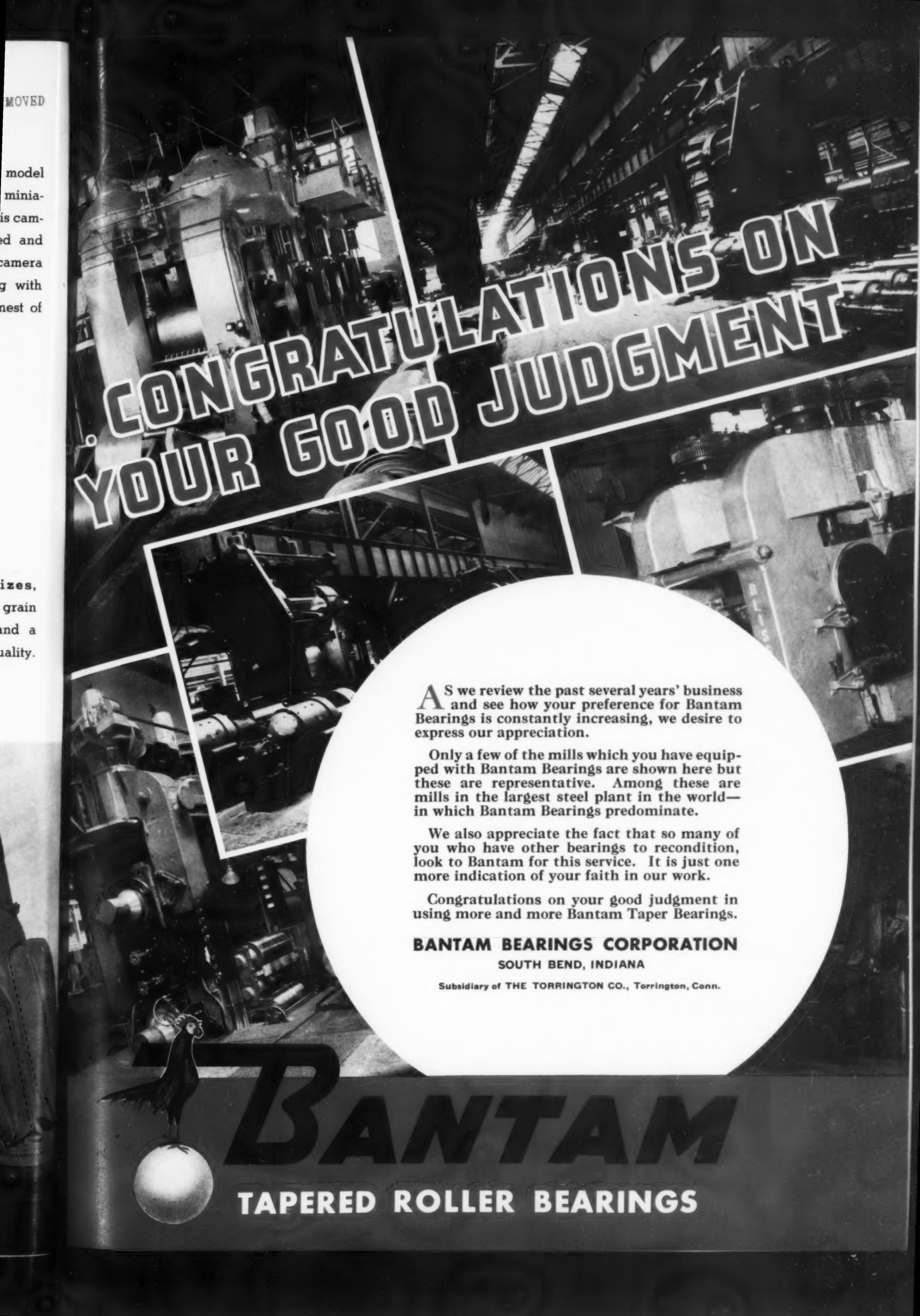
First prize will be this model G Leica, the ultimate in miniature cameras. Briefly, this camera is the most advanced and desirable in the entire camera field and has everything with which to produce the finest of photographs.

▲

Second and **third prizes,** shown below, are a top grain leather Gladstone bag and a golf bag of excellent quality.

Steel Men

win one of the $500.00 worth of prizes which will be awarded at the coming Iron and Steel Exposition, Stevens Hotel, September 28, 29, 30 and October 1. First prize will be a model G Leica camera. Second and third prizes are a traveling bag and a golf bag. There will be ten other prizes valued at $20.00 each. Details on how to win one of these prizes will be furnished at the convention registration desk, Stevens Hotel. Only operating and executive personnel in the industry may compete for these awards.



AS we review the past several years' business and see how your preference for Bantam Bearings is constantly increasing, we desire to express our appreciation.

Only a few of the mills which you have equipped with Bantam Bearings are shown here but these are representative. Among these are mills in the largest steel plant in the world—in which Bantam Bearings predominate.

We also appreciate the fact that so many of you who have other bearings to recondition, look to Bantam for this service. It is just one more indication of your faith in our work.

Congratulations on your good judgment in using more and more Bantam Taper Bearings.

BANTAM BEARINGS CORPORATION

SOUTH BEND, INDIANA

Subsidiary of THE TORRINGTON CO., Torrington, Conn.

BANTAM

TAPERED ROLLER BEARINGS

TENTATIVE PROGRAM

33RD ANNUAL CONVENTION AND IRON AND STEEL EXPOSITION

CHICAGO, ILLINOIS

STEVENS HOTEL

SEPTEMBER 28, 29, 30, AND OCTOBER 1, 1937

TUESDAY, SEPTEMBER 28, 1937

9:00 A.M. Third Floor.

Registration

CHAIRMAN	VICE CHAIRMAN
H. G. HAGUE, Electrical Superintendent Sheet and Tin Plate Division Carnegie-Illinois Steel Corp. Gary, Indiana	WALTER H. BURR, Electrical Superintendent Lukens Steel Company Coatesville, Pennsylvania

BUSINESS SESSION

North Ball Room, Third Floor

CHAIRMAN	VICE CHAIRMAN
H. G. R. BENNETT Assistant General Superintendent Carnegie-Illinois Steel Corp. Duquesne, Pennsylvania	J. L. MILLER Assistant Combustion Engineer Republic Steel Corporation Cleveland, Ohio

9:15 A.M.

Annual Meeting and Business Session of Association of Iron and Steel Engineers.

9:30 A.M.

TECHNICAL SESSION

CHAIRMAN	VICE CHAIRMAN
F. D. EGAN, Electrical Superintendent Bethlehem Steel Company Lackawanna, New York.	WILLIAM A. PERRY, Superintendent of Elec. and Power Inland Steel Company Indiana Harbor, Indiana.

"THE TESTING DEPARTMENT OF A LARGE STEEL COMPANY" by Birger Thele, Test Engineer, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama.

"LAYOUT AND INSTALLATION OF LOW VOLTAGE D. C. AND A. C. SYSTEMS IN STEEL PLANTS" by Donald Nelson, Assistant Electrical Engineer, Jones & Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

"SURGES AND THEIR EFFECT ON TRANSFORMERS" by H. Weichsel, Consulting Engineer, Wagner Electric Corporation, St. Louis, Missouri.

Combustion Engineering Division

South Ball Room, Third Floor

9:30 A.M.

CHAIRMAN	VICE CHAIRMAN
A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.	T. J. ESS, Combustion Engineer, Republic Steel Corporation, Massillon, Ohio.

"PROTECTIVE ATMOSPHERE FOR ANNEALING FURNACES IN STEEL MILLS" by A. N. Otis, General Electric Company, Schenectady, New York.

"COMPLETE CONTROL OF RECUPERATIVE AND REGENERATIVE SOAKING PITS" by A. E. Krogh, Market Development Department, Brown Instrument Company, Philadelphia, Pennsylvania.

Boulevard Room

12:15 P.M.

Welcome Luncheon

TUESDAY, SEPTEMBER 28, 1937

North Ball Room

2:00 P.M.

Combustion Engineering Division

CHAIRMAN	VICE CHAIRMAN
W. S. HALL, Chief Engineer, Chicago District, Carnegie-Illinois Steel Corp. Chicago, Illinois.	FRANK E. LEAHY, Combustion Engineer, Youngstown Sheet & Tube Company Youngstown, Ohio.

"STEAM POWER DEVELOPMENTS" by Charles W. E. Clarke, Consulting Engineer, United Engineers and Constructors, Inc., Philadelphia, Pennsylvania.

"DESIGN AND OPERATION OF NEW BOILER HOUSE—OHIO WORKS, CARNEGIE-ILLINOIS STEEL CORPORATION" by C. H. Williams, Assistant Chief Engineer, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

"THE DEVELOPMENT OF STEAM GENERATION FROM GAS ENGINE EXHAUST IN AMERICA" by T. A. Lewis, Assistant Combustion Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania.

North Assembly Room, Fourth Floor

2:00 P.M.—5:00 P.M.

LADIES CARD PARTY AND TEA

Boulevard Room, Second Floor

10:00 P.M.

Exhibitors Dance, Informal

WEDNESDAY, SEPTEMBER 29, 1937

North Ball Room, Third Floor

9:00 A.M.

CHAIRMAN
G. R. CARROLL,
Electrical Superintendent,
Jones & Laughlin Steel Corp.
Aliquippa, Pennsylvania.

VICE CHAIRMAN
A. W. STEED,
Superintendent of Maintenance,
American Rolling Mill Company,
Middletown, Ohio.

"ORGANIZATION AND FUNCTIONS OF A STEEL PLANT MAINTENANCE DEPARTMENT" by T. E. Hughes, Superintendent of Maintenance, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

"FACTORS INFLUENCING THE SELECTION OF INSULATED CABLES FOR STEEL MILLS" by F. L. Aime, Electrical Engineer; S. J. Rosch, Manager Insulated Products Development and R. B. Steinmetz, District Engineer of the Anaconda Wire and Cable Company, Hastings-on-Hudson, New York.

Lubrication Engineering Division

South Ball Room, Third Floor

9:00 A.M.

CHAIRMAN
C. C. PECU,
Lubrication Engineer,
Bethlehem Steel Company,
Lackawanna, New York.

VICE CHAIRMAN
F. L. GRAY,
Lubrication Engineer,
Carnegie-Illinois Steel Corp.
Gary, Indiana.

"REASONS GOVERNING THE USE OF E. P. LUBRICANTS—APPLICATIONS AND METHODS OF USE" by Ralph C. Walters, Penola, Inc., Chicago, Illinois.

"LUBRICATION OF MORGOIL ROLL NECK BEARINGS" by H. H. Wood, Engineer, Morgan Construction Company, Worcester, Mass.

"STEEL MILL LUBRICATION AND LUBRICANTS FOR ANTI-FRICTION BEARINGS" by O. L. Maag, Timken Roller Bearing Company, Canton, Ohio.

12:30 P.M.

Inspection Trip to Gary Sheet and Tin Plate Division, Carnegie-Illinois Steel Corporation, Gary, Indiana.

1:30 P.M.

Ladies City Sight-Seeing Trip

THURSDAY, SEPTEMBER 30, 1937

North Ball Room, Third Floor

9:00 A.M.

CHAIRMAN
C. L. MCGRANAHAN, Assistant
General Superintendent,
Jones & Laughlin Steel Corp.
Pittsburgh, Pennsylvania.

VICE CHAIRMAN
JAMES FARRINGTON,
Electrical Superintendent,
Wheeling Steel Corporation,
Steubenville, Ohio.

"D. C. DRIVES FOR MILL RUN OUT TABLES AND COILERS" by L. A. Umansky, General Electric Company, Schenectady, New York.

"CORROSION PROOF TANK LININGS" by Roy C. Werking, National Carbon Company, Cleveland, Ohio.

"ELECTROLYTIC CLEANING LINES FOR REMOVAL OF OIL FROM STRIP STEEL" by M. Stone, Engineer, Development, United Engineering and Foundry Company, Pittsburgh, Pennsylvania.

"THE FUTURE POSSIBILITIES OF PRODUCING VARIOUS STRUCTURAL SHAPES BY THE COLD ROLL FORMING OF STRIP STEEL" by Howard W. Kane, Kane & Roach, Inc., Syracuse, New York.

Welding Engineering Division

South Ball Room, Third Floor

9:00 A.M.

CHAIRMAN
G. A. HUGHES,
Chief Electrical Engineer,
Truscon Steel Company
Youngstown, Ohio.

VICE CHAIRMAN
WRAY DUDLEY,
Electrical Superintendent,
National Tube Company
McKeesport, Pennsylvania.

"WELDING ECONOMICS AND APPLICATION" by E. W. P. Smith, Consulting Engineer, Lincoln Electric Company, Cleveland, Ohio.

"THE DEVELOPMENT AND APPLICATION OF COVERED ELECTRODE ARC WELDING" by A. M. Candy, Consulting Engineer, Hollup Corporation, Chicago, Illinois.

"ALTERNATING CURRENT ARC WELDING ADVANCE" by C. J. Holslag, Electric Arc Cutting and Welding Company, Newark, New Jersey.

MOTION PICTURES by Clyde Bassler, Taylor Winfield Corporation, Warren, Ohio.

THURSDAY, SEPTEMBER 30, 1937

North Ball Room, Third Floor

1:30 P.M.

CHAIRMAN
FRANK E. FLYNN, General
Manager, Warren District,
Republic Steel Corporation,
Warren, Ohio.

VICE CHAIRMAN
JULIUS A. CLAUSS,
Chief Engineer,
Great Lakes Steel Corporation,
Ecorse, Michigan.

"THE MANUFACTURE AND USE OF IRON AND STEEL ROLLS" by Walter H. White, General Superintendent and F. L. MacQuarrie, Chief Engineer, Pittsburgh Rolls Corporation.

"NOTES ON BLAST FURNACE DESIGN AND PRACTICE" by A. J. Boynton, Vice-President, H. A. Brassert & Company, Chicago, Illinois.

"DEVELOPMENTS IN ROLLING FLAT STEEL PRODUCTS DURING 1937" by Stephen Badlam, Consulting Engineer, Pittsburgh, Penna.

Boulevard Room, Second Floor

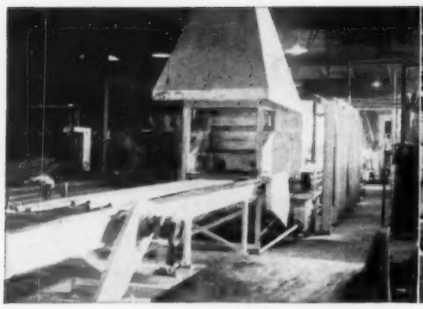
6:30 P.M.

Banquet and Dance

FRIDAY, OCTOBER 1, 1937

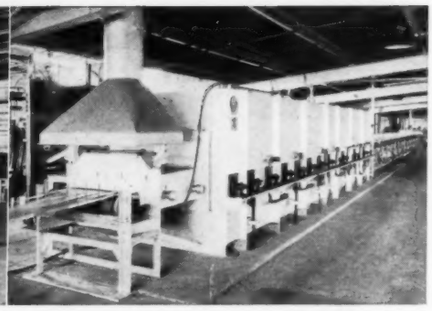
9:00 A.M.

Inspection Trip to Hot and Cold Strip Mills, Inland Steel Company, Indiana Harbor, Indiana.

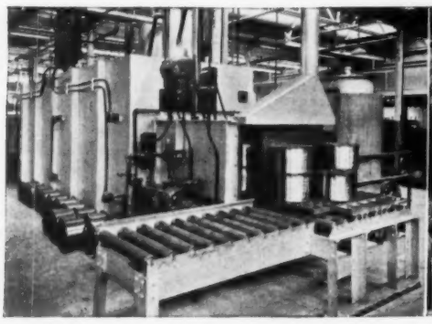


BRIGHT ANNEALING STEEL TUBING
—continuously—various lengths and diameters

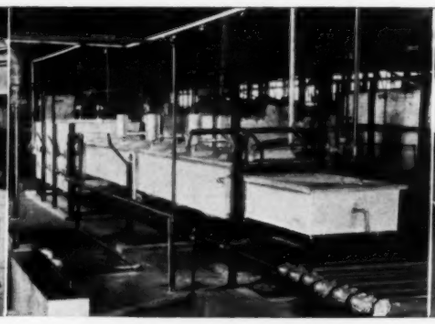
BRIGHT ANNEALING STAMPINGS
—continuously—ferrous and non-ferrous



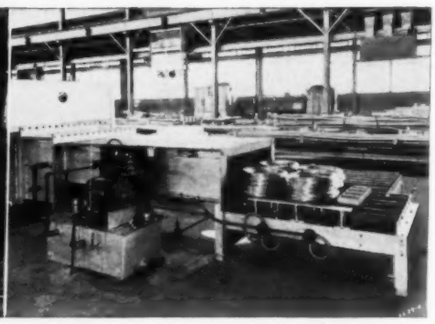
BRIGHT ANNEALING STEEL IN STRIP
—more uniform anneal and finish



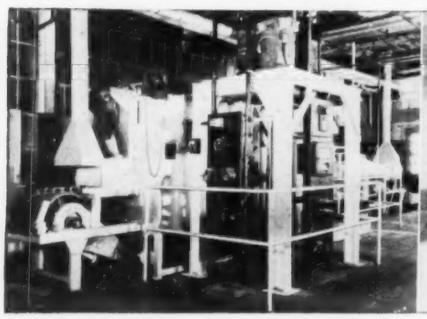
BRIGHT ANNEALING COPPER WIRE
—on large reels—36,000 lbs. per day



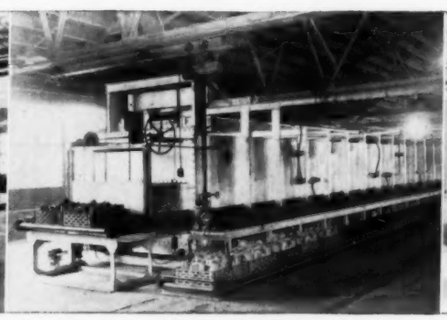
BRIGHT ANNEALING FINE WIRE
—on small spools—5 tons per day



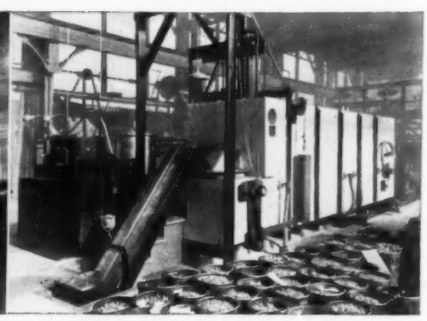
BRIGHT ANNEALING COILED WIRE
—Bronze, Copper, Nickel Silver, etc.



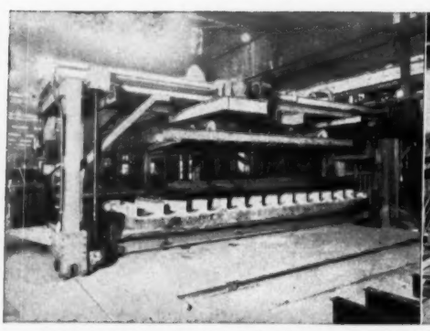
COPPER BRAZING STEEL ASSEMBLIES
—economically and continuously



CLEAN ANNEALING SHORT CYCLE
MALLEABLE CASTINGS



SCALE FREE HARDENING BOLTS
—in continuous chain belt furnaces—1000 lbs. per hr.



HEAT TREATING ALLOY STEEL BARS
—quench in background

HEAT TREATING 90 FOOT LENGTHS
—uniformly and continuously

FUEL-FIRED BILLET HEATING FURNACES
—built in any size for oil or gas

Some Electric and Fuel Fired Furnaces Designed and Built by

The Electric Furnace Co., Salem, Ohio

We Build Gas Fired and Electric Furnaces For Any Process, Product or Production

INDIVIDUAL MOTOR DRIVES on Wide Strip Mills

By F. E. HARRELL
Asst. Chief Engr.

and

W. R. HOUGH
Experimental Engr.

Reliance Electric & Engineering Co.
CLEVELAND, OHIO

Presented before the Annual Convention of the A. I. & S. E., Detroit, Michigan, Sept. 22-25, 1936

▲ AMONG all of the continuous strip mills built in the past several years, no two of them have exactly duplicate installations of runout table and coiler drives, including the adjustable frequency sets.

This interesting situation may signify several things —first, that as yet it appears there is no "best way" to satisfactorily meet all of the varied conditions to be encountered in various mills. Many different schemes of operating these tables and coilers are at present employed with satisfaction. In fact, it is regularly reported that some different mill has just established a new tonnage record. On the other hand, it does not follow at all that just any type of drive for runout table and coiler will prove satisfactory, but rather that there are several methods of operating a continuous mill, each of which prove perticularly effective under the right combination of operating conditions and personnel. It has been stated by several of the engineers involved in new mill projects that relatively it is much easier to settle on 3000 hp. main drives than on what were at one time considered unimportant auxiliaries.

Following the suggestion offered on the floor of this convention a year ago, it shall be the object of this paper to present oscillographic studies of runout table and coiler drives and their adjustable frequency motor alternator sets as now in operation in various wide strip mills.

The authors desire to hereby extend thanks to The Great Lakes Steel Corporation, the Otis Steel Company and the others cooperating in the securing of test results and information made available herewith to this Association.

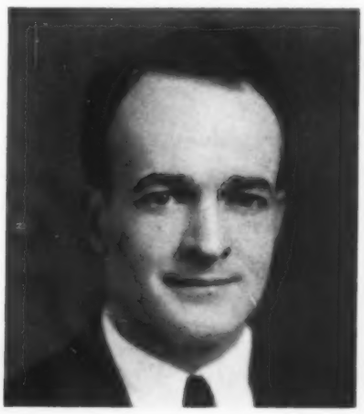
Inasmuch as the oscillograph usually detects and records many new and otherwise hidden facts about the operation of equipment on which its charts are taken, it is likely that there will be additional interpretations beyond those offered by the authors from the charts contained herein.

Figure 1 is a schematic diagram of the finishing end of a hot strip mill of present day design.

Again considering the variety of installations of individually driven runout table rolls, there are those which start by the so-called frequency control—all motors thrown on the adjustable frequency motor-alternator set operating at low speed, then accelerated to top speed by means of speed and frequency change of the set. There are those which start all together by being thrown directly onto the alternator at operating frequency. There are also those operated by so-called group starting, wherein portions of the total number of motors on a table are thrown successively onto the alternator at operating frequency.

F. E. HARRELL

W. R. HOUGH



Rather than being competitive, the foregoing methods are strictly supplementary, as each serves a most useful function incident to a certain scheme of planned operations.

If run out to coil or to pile are the principal functionsof a table, and it is anticipated that incident to the variety of product either in sec-

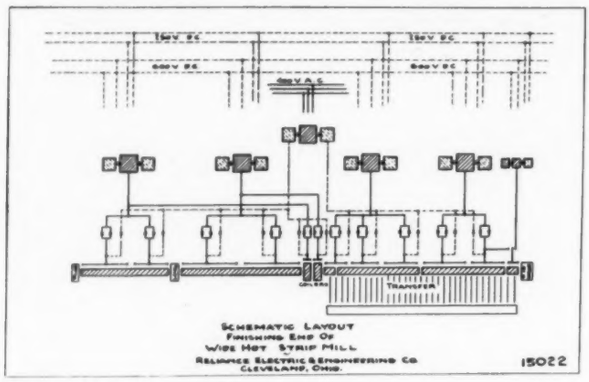


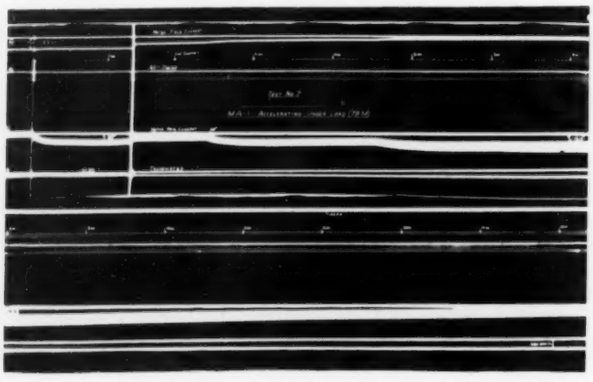
Figure 1—Schematic layout—Finishing end of wide hot strip mill.

tion or physical properties it may be necessary to regularly change the speed of the whole table together with each strip or bundle, then the so-called frequency control may well be employed with its attendant economy.

Continuous running tables, or those whose function it may be to start very infrequently, or those which may be so laid out as to use direct-connected motors with eight or more poles, may well employ the method of starting all together at operating frequency.

There are also mills laid out with relatively short hot run tables, or with a transfer table on only one side, but still with the requirement that two strips per minute be discharged. This of necessity involves stopping in a shorter space and time together with a more rapid rate of acceleration in preparation for receiving the next strip from the mill. The most practicable method known for such a set of conditions is the so-called group starting, whereby after being stopped, the table is started in sections beginning at the mill stand and extending outward. When a duty cycle involves starting a table in less than approximately four seconds time to top speed, it is extremely likely that group starting will prove to be the desirable method.

Figure 2—Oscillograph chart of D.C. end of motor-alternator set accelerating 78 table rollers from 665 feet per minute to 1700 feet per minute.



Having referred to the economy of the frequency control system, it may be in order to introduce at this point the exact figures disclosed by an investigation of the relative efficiency of these three methods from the standpoint of power consumption.

By integrating the d-c. current curves shown by the oscillograph, Fig. 2 and 3, taken on a frequency control installation over the total time of acceleration and deceleration of actual mill tables in operation, the total "input" from the mains is determined in watt seconds, the voltage being known, by integrating the d-c. current curves shown on these charts, using the time scale presented by the 60 cycle timing wave. The actual work done or the "output" is considered to be production of the kinetic energy in the table rolls and motor rotors occasioned by their being raised to a known speed. Similarly in deceleration, the work done is the absorption of the total kinetic energy in table rolls and motor rotors. For the purpose of this comparison this energy is translated into terms of watt seconds by this formula.

$$\text{Watt Seconds} = \frac{WR^2 \text{ in lbs. ft. sq. x } RPM^2}{4340}$$

In the frequency control system, the acceleration of the MA set is not included as work done since in deceleration this same energy makes possible a vast additional pumpback of power, which is credited to the system. Also charged against the pumpback is the input from the mains necessary to supply the d-c. braking set used to stop the table or coiler motors from the base speed of the MA set.

It is also interesting that the efficiency in starting and stopping by group starting and by starting all together at operating frequency is identical. In group starting, Fig. 4, portions of the table are up to 1375 f.p.m. speed in 1.77 seconds, but the last section is up to speed after 5.765 seconds, where by starting the same table all together the total time was 7.5 seconds, but, of course, in the latter case no portion of the table was ready to receive material at top speed until the entire table was accelerated.

The exact figures are given below in watt seconds.

FREQUENCY CONTROL

78 motors with MA set to 2000 F.P.M. table speed.

	Output	Power Input
START	1,870,000	7,918,000
STOP	1,870,000	2,229,250
Total for cycle	3,740,000	5,688,750

Overall Efficiency for Start and Stop Cycle.....65.8%

	Power Input
Pumpback	3,157,000
Motoring	222,750
NET PUMPBACK	2,934,250
Less D-c. Braking Input	705,000
NET PUMPBACK	2,229,250

GROUP STARTING
OR
STARTING ALL TOGETHER
72 motors to 1375 f.p.m. table speed.

	Output	Input
START	310,000	1,033,000
STOP	310,000	494,500
Total for cycle	620,000	1,527,500

Overall Efficiency for Start and Stop Cycle.....40.5%

Just as in all lines of endeavor, expenditures usually represent value received so in this case deceleration in the frequency control scheme was accomplished at the rate of 285 ft. per minute per second, while in the group starting d-c. braking scheme, deceleration was at the rate of 935 ft. per minute per second.

For the sake of comparison, if the 1375 f.p.m. table above should be operated on frequency control at an overall efficiency of 65.8%, then the difference in power between these methods on a 200 foot table running up to 1375 f.p.m. would be .163 kilowatt hours, which if valued say half a cent per kilowatt hour, would amount to eight tenths of a mil per reversing cycle as the premium for the higher rate of deceleration.

It is obvious, therefore, that if the higher rate of deceleration should result in avoiding the scrapping of a single bundle, then this almost negligible power premium would be well expended.

In a consideration of the total functions of a runout table, namely, start or accelerate, run, and stop or decelerate, it seems logical to take them up in that order.

Referring to Fig. 2, we have a chart of the d-c. end of an alternator set powering 78 gearmotors operating a wide hot strip mill table during acceleration to 1700 f.p.m. With the timing wave, an accurate picture is portrayed of the rate of acceleration, together with the field and armature currents.

This particular chart is taken from a set operated by four step, adjustable time limit field accelerating relays. Among other things a study of the interrelation of the three functions shown on this chart, d-c. armature current, d-c. field current and MA set speed, dictated a change in both the timing and apportioning of resistance values successively cut in to the d-c. motor field. Fig. 5 indicates a different arrangement of the timing of the accelerating contactors of the same type of control.

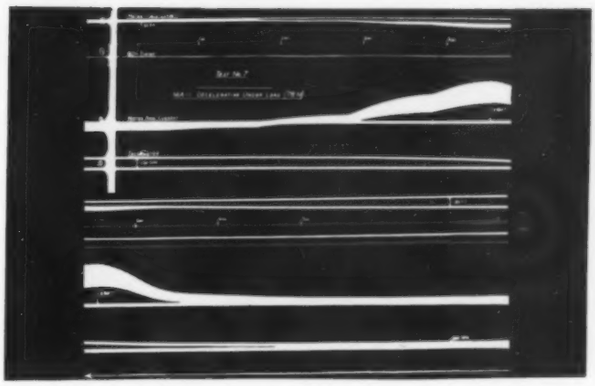
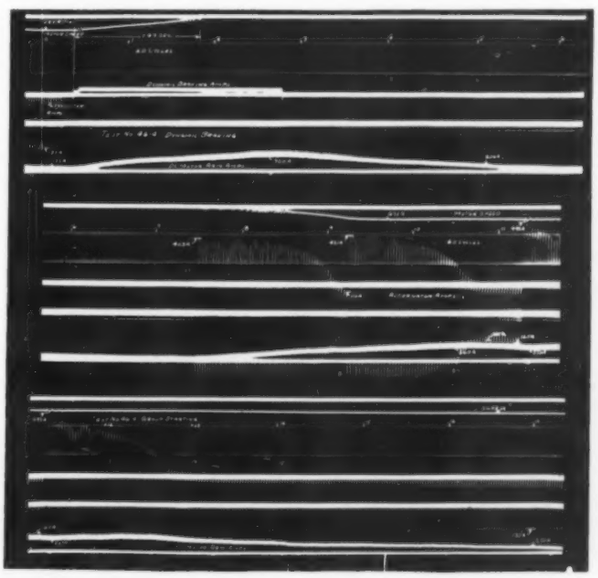


Figure 3—Oscillograph chart of D.C. end of motor-alternator set decelerating 78 table rollers from 1850 feet per minute to 665 feet per minute.

It is apparent from Fig. 2, and consistently shown by other chart studies of other sets and mills, that acceleration through frequency control is accomplished to approximately two-thirds of top speed in approximately one-third of the time. In other words, a table operating up to 1500 f.p.m. may be shown by the oscillograph to be up to 1000 f.p.m. in four seconds, but requiring twelve seconds to reach the final 1500 f.p.m. speed.

Observation of mills in operation after studying these charts will indicate possible directions to move in methods of operation to secure the effect of higher rates of acceleration without subjecting the mechanical

Figure 4—Oscillograph chart of dynamic braking from 1375 feet per minute and group starting to 1330 feet per minute of 72 table rollers.



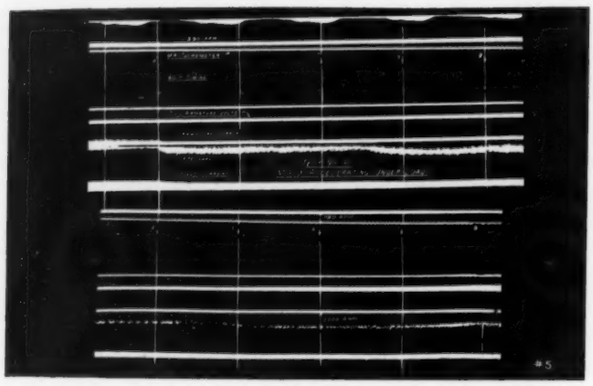


Figure 5—Oscillograph chart of D.C. end of motor-alternator set accelerating 172 table rollers from 665 feet per minute to 1500 feet per minure

equipment to the additional stresses of more rapid acceleration.

The a-c. or alternator end of the same MA set is shown in acceleration in Fig. 6. The changing frequency is immediately apparent on viewing the voltage curve. Two additional points become apparent. The voltage regulation inherent in an alternator does a very fair job of protecting it. In other words, as the alternator is more heavily loaded, the voltage falls off, which act immediately relieves the load.

Concern is often expressed as to overloads in a-c. current taken from MA sets on runout tables. As a matter of fact, alternator temperature is really the primary concern incident to these current peaks. It is seldom found that the maximum alternator loading imposed by a frequent starting results in serious overheating of the alternator stator. As shown by the voltage regulation curve on a typical runout table alternator, Fig. 7, 375% load with 150% excitation at 50% power factor reduces the alternator voltage to zero which immediately relieves the load since zero voltages on the table motors produces no power requirement. It would be more likely that alternator field heating would be most likely to give concern since the presence of the field forcing current for a prolonged period would rapidly overheat the fields.

Again referring to time, Fig. 6 shows acceleration to approximately 600 f.p.m. table speed in 1.5 seconds without exceeding 65% of the rated current of the alternator. Dividing the a-c. current shown among the total motors connected, it is found that acceleration was accomplished at about 90% of rated motor torque as indicated by the current reading above.

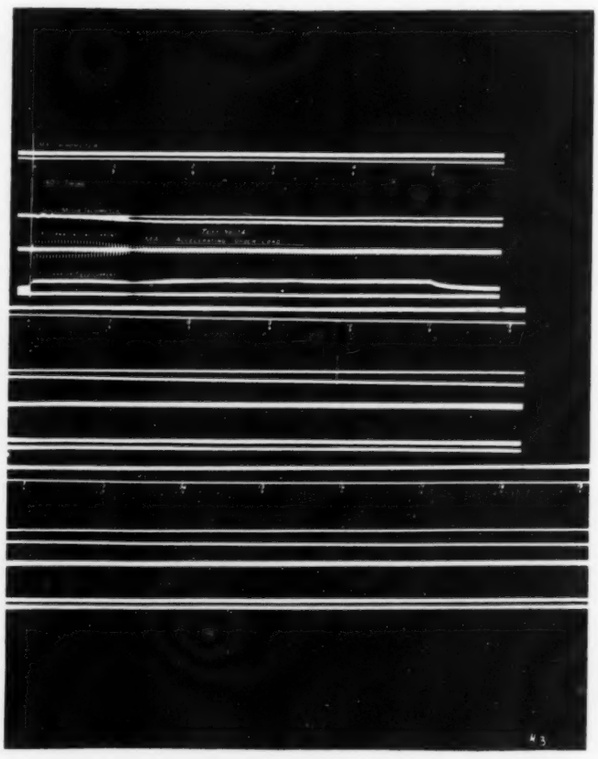
It is also shown by Fig. 6 that in this case 19 seconds were consumed in acceleration of the set from 26 to 78 cycles. Other oscillographs show acceleration from 26 to 73 cycles in 14 seconds, and 26 to 66 cycles in 11 seconds. It must be fully appreciated that a wide variation in rate of acceleration may be secured by the adjustment of the rate of change of field current on the d-c. motors.

The results shown in Fig. 2, 3 and 4 cover a 4-step field acceleration, while Fig. 8, though not covering a chart of a set in the act of speed changing, indicates the nature of the effect on armature and field currents of flutter switch operation in controlling the d-c. motor field current as actuated from the armature current.

Another method of field control regularly employed very effectively, but not illustrated here by oscillograph, is that to be secured by a motor operated rheostat. In several instances on relatively large motors where commutation troubles were encountered by manual operation of a field rheostat for acceleration and deceleration, not only was the commutation markedly improved, but the rate of acceleration and deceleration was increased by the use of motor operated rheostats which accomplished a field change gradually, but as rapidly as the mutual inductance and time lag in the field was able to employ the changed current value. Here it is, of course, desirable to depart from a straight line relation of rheostat points to ohms and fill the rheostat according to that parabolic curve which will result in giving the desired rate of field change.

Charted in Fig. 9 is a table of 72 direct-connected motors operated at 1240 f.p.m. showing a timing wave, alternator voltage, alternator current, alternator field current and runout table motor speed. From this chart can be observed particularly well the behavior of an alternator at group starting. With the MA set running light, the first group of motors is thrown on simultaneously with field forcing on tthe alternator field. The rated alternator current is 314 amperes. The first peak is 397 amperes or 126% full load with a voltage of 355. The current then falls to 71 amperes in 1.6 seconds, the voltage rising to 465. At 1.75 seconds the

Figure 6—Oscillograph chart of A.C. end of motor-alternator set starting and accelerating 78 table rollers to 195 feet per minute.



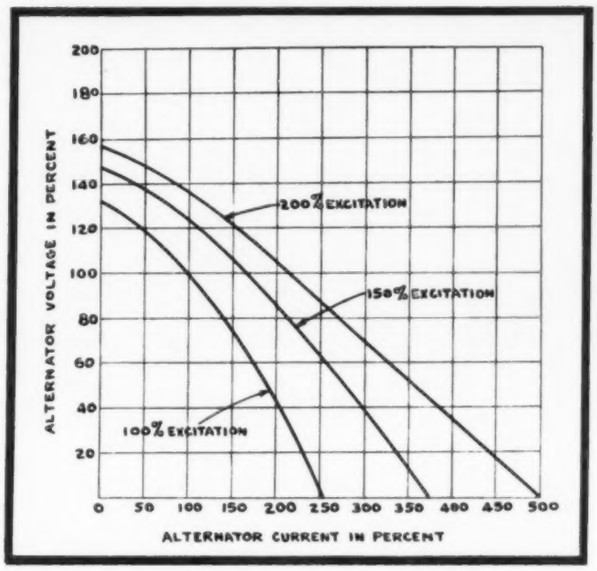


Figure 7—Curves showing voltage regulation of typical run out table duty 50% power factor alternator.

second group goes on producing a 438 ampere peak or 138% load dropping the voltage to 355. 1.35 seconds after the second group goes on, the current has fallen to 136 amperes. Before the third group goes on the voltage has risen to 455. 2.08 seconds after the second group, the third group goes on with a 465 ampere peak or 148% load, droping the voltage to 360. 1.27 seconds later the voltage has risen to 395 when the field forcing is removed from the alternator. In another .9 seconds the voltage has fallen to 355 volts with normal current of 142 amperes.

It is shown that 1.6 seconds after the master switch was operated the first group or the first 60 foot length of the table beyond the No. 10 mill stand was up to 1240 f.p.m. speed ready to receive strip from the mill. At this speed the strip is traveling 20.6 ft. per second, so that the second 60 foot length was prepared to receive material at full speed 1.37 seconds before the material would have arrived at that point.

Concerning the d-c. loading of the MA set motor, it can be observed from Fig. 4 that incident to acceleration, full load current of 700 amperes is never exceeded.

Coming now to running conditions, there is little to be learned by oscillograph from continuous running tests. As a rule, any combination of set and motors which will be satisfactory for acceleration and deceleration is apt to handle any running condition encountered. On the other hand it is not good practice to work too closely to the limit of either motors or set. So many things can and are encountered in practive in the way of temperature and friction conditions, as well as occasional mechanical difficulties incident to changes in table and roll alignment that as a load spread 3:1 is not uncommon to be encountered over a period of time.

Running loads per roller on wide mill tables range from less than 1 hp. on small diameter direct-connected

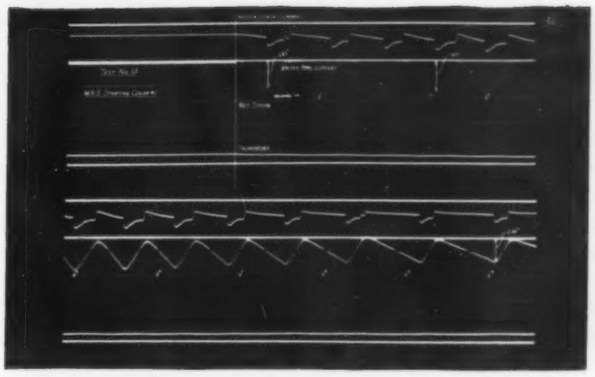


Figure 8—Oscillograph chart of acceleration of coiler showing effect on D.C. driving motor of flutter switch control.

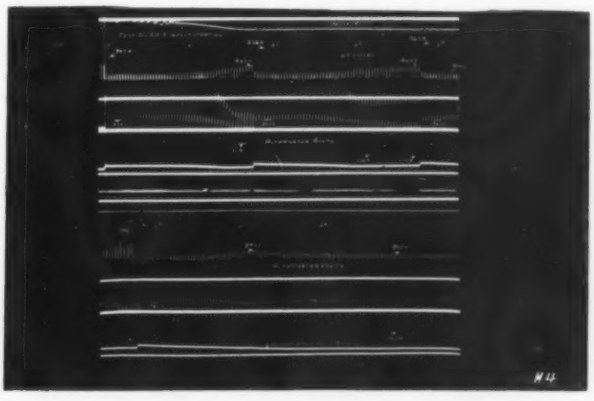
rolls. On larger diameter rolls, loads vary from slightly under 2 hp. at normal conditions to as high as 4 or 5 hp. under abnormal conditions, which are not expected to be permitted except in an emergency. All of these figures refer to table speeds of 1600 f.p.m.

To be still more specific, the average running kw. per foot of table length at 1600 f.p.m. speed is from .42 kw. to .6 kw. for a gearmotor driven roll and .25 kw. to .3 kw. for a direct-connected roll.

In discussing deceleration, frequency control with deceleration through the sets to their base speed shall be first considered.

Fig. 3 covers the d-c. end of an MA set driving 78 gearmotors at 1850 f.p.m. during acceleration. From both the field and armature charts the instant of closing of the four decelerating relays can be determined. The big current peak in the armature circuit attaining values up to 400% full load is a feature of the regenerative effect of this type of operation. In this connection a comparison of Fig. 10 and 11 aptly illustrates the difference in regenerative braking secured by readjustment of the timing relays. It is by the same token illustrative of how armature current can be controlled by regulation of rate of change of field current.

Figure 9—Oscillograph chart of motor-alternator set starting and accelerating 72 table rollers to 1240 feet per minute.



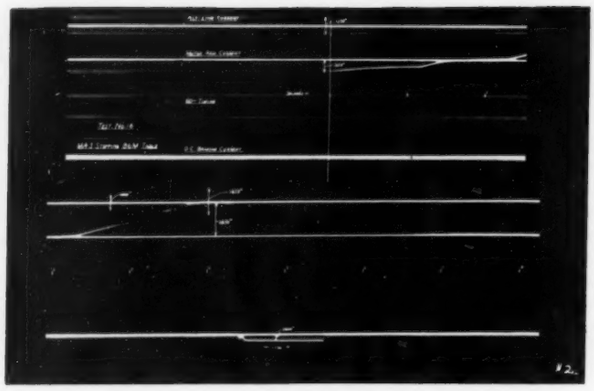


Figure 10—Oscillograph chart showing deceleration and dynamic braking of 172 table rollers.

One interesting outgrowth of Fig. 3 was the disclosure that while the control function was to reduce the d-c. motor to full field speed, then take the a-c. off the table motors and put on d-c. braking, what was actually happening was that the relay functions were complete and the table motors removed from the set and put on d-c. braking when still running at slightly over a 60-cycle speed instead of from base frequency. A stop watch visual observation of this operation failed to reveal this condition.

Fig. 12 charts a start and a stop on a table of 72 motors operated from 1215 f.p.m. showing a timing wave, d-c. armature current, alternator loading, MA set speed and d-c. braking current. In this case the d-c. braking generator was coupled as an additional unit on the MA set. It can be seen from Fig. 4 that deceleration by d-c. braking from 1375 f.p.m. was accomplished in 1.47 seconds or at the rate of 935 ft. per minute per second. It is reported that no evidence is available to indicate slippage of material on the rolls in stopping at this rate and that no damage to the strip results. It is also of interest to note that the maximum d-c. current peak over this start and stop cycle is occasioned at the instant of d-c. braking and is less than full load on the motor.

Deceleration is, of course, dependent on two things: Motor torque available for braking and coefficient of friction of strip to roll, table and side guards. The maximum rate of deceleration must be dependent on both of these things as of any instant.

It has been the common conception in the past that the most desirable means for stopping loaded runout tables most quickly is with a flat speed torque braking curve of the highest practicable value because the co-efficient of friction was also a constant value.

Here are three evidences that this may not be true. First, the mechanics employed in stopping the new high speed trains. There is an automatic stop put on the braking pressure when the train is running over 60 miles per hour, since if full pressure were applied at say 120 miles per hour, the wheels would be locked and slide on the rails approximately twice the distance required for stopping by applying first, a reduced braking pressure until the speed is down to about 60 miles per hour, then applying full pressure and coming quickly to rest. This is exactly the shape of speed torque curve presented by d-c. braking a squirrel-cage induction motor of either normal torque, semi-high torque, or full high torque characteristic as illustrated by Fig. 13.

Second, there have been reported cases of runout tables which are plug reversed for stopping (where the braking curve is relatively flat) where the sheet skidded on the table instead of stopping quickly.

Third, the tables in the industry today which stop at the highest rate of deceleration are stopped by d-c. braking.

These evidences all point to the conclusion that the co-efficient of friction of steel strip to conventional

Figure 11—Oscillograph chart of D.C. end of motor-alternator set decelerating 172 table rollers from 2000 feet per minute.

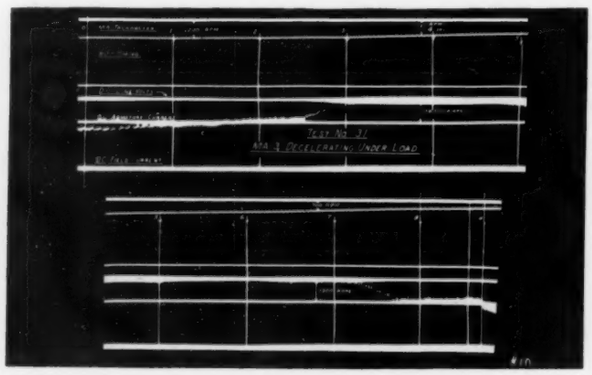
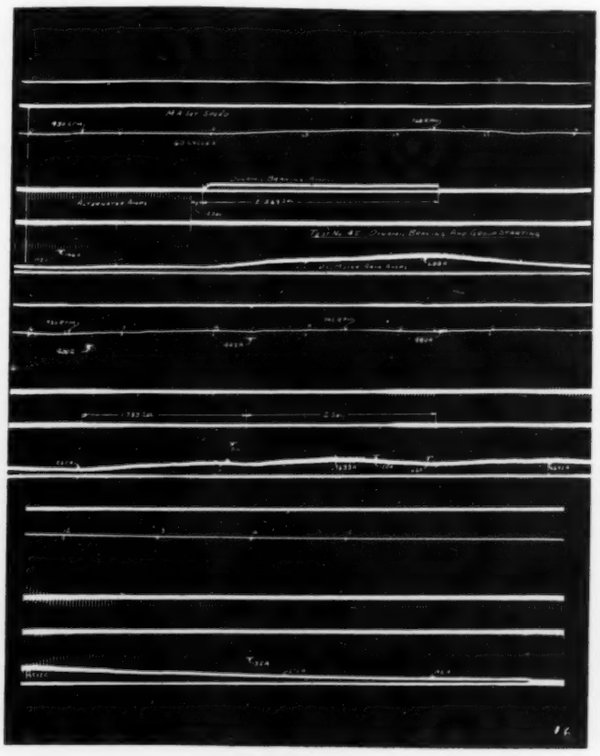


Figure 12—Oscillograph chart of dynamic braking and group starting of 72 table rollers from and to 1215 feet per minute.



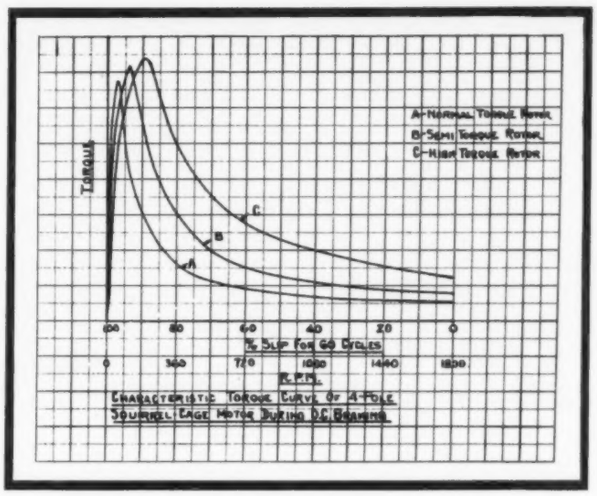


Figure 13—Characteristic torque curve of 4-pole squirrel-cage motor during D.C. braking.

table construction is a variable function changing inversely as some power of the speed.

So much for the test results of acceleration, running and deceleration by two methods of operation.

Inasmuch as the operation representing the limiting condition in coiling is that of pulling in a cold strip representing some difficulty in production, it has not been the authors' good, or ill, fortune to secure an oscillograph chart on such a coiling operation. To pull in a cold strip made from a slab weighing up to eight tons represents so much more than normal running capacity of an alternator set that it has become common practice to operate the internal expanding type of hot strip reel off the MA sets alternatively supplied for piler tables not in use when coiling. Such sets are of necessity and desirability of such size that oscillograph charts of normal running of a coiler shows very little of interest. Figures 14 and 15 show respectively charts of the d-c. and a-c. ends of an MA set, powering a coiler and showing it during acceleration. Fig. 16 similarly shows a chart of the d-c. end of a coiler set during deceleration.

Since coiler design of necessity places space available for individual roll motor at a premium, it logically follows that the most practicable means to provide that over-capacity required on occasion from the coiler motors, is to have them powered from an MA set of such liberal capacity that it can apply an overvoltage on the coiler motors even under the locked rotor condition.

Fig. 17 shows the loading imposed on the alternator driving a coiler including two pinch roll motors starting with the coiler running at high speed and showing the complete coiling and decelerating period. It is interesting to note that the peak load occurs within three seconds after the strip enters the coiler, indicating that the peak load is caused by accelerating the strip to the coiler speed, rather than by the size of the full bundle. The current continually decreases as the coil builds up. The pulsating current wave during deceleration is due to the flutter switch type of control.

The opportunity was also presented by facilities available at one of the mills to secure a direct comparison on a mill table of plugging runout table motors to rest from 570 f.p.m. versus d-c. braking the same table to rest from 700 f.p.m. Figures 18 and 19 show the oscillograph of plugging and Fig. 20 of d-c. braking. Briefly summarized and brought to comparable speeds they show:

	Seconds) Time to Stop	(Watt Seconds) Input per Motor	(Watt Seconds) Kinetic Energy	(Watt Seconds) Total Loss per Motor
Plugging....	2.13	12,700	3,440	16,140
D-c. Braking	1.3	6,180	3,440	9,620

In this instance stopping by d-c. braking is done in 60% of the time with 50% of the power input and 60% of the resultant motor heating as compared with plugging.

Figure 14—Oscillograph chart of D.C. end of motor-alternator set accelerating coiler.

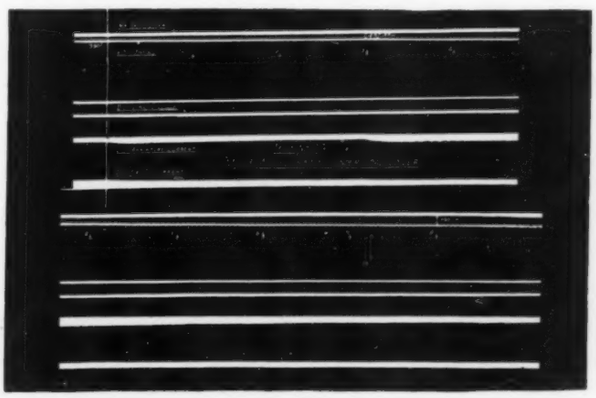
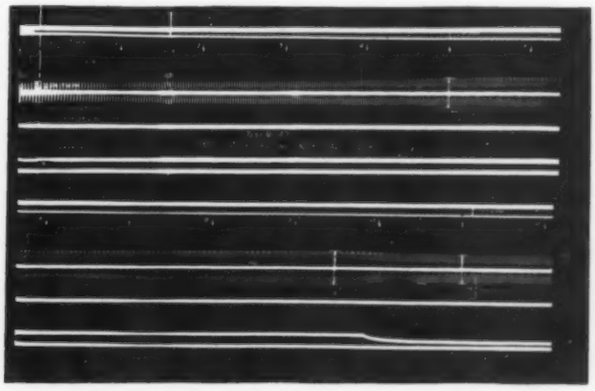


Figure 15—Oscillograph chart of A.C. end of motor-alternator set accelerating coiler.



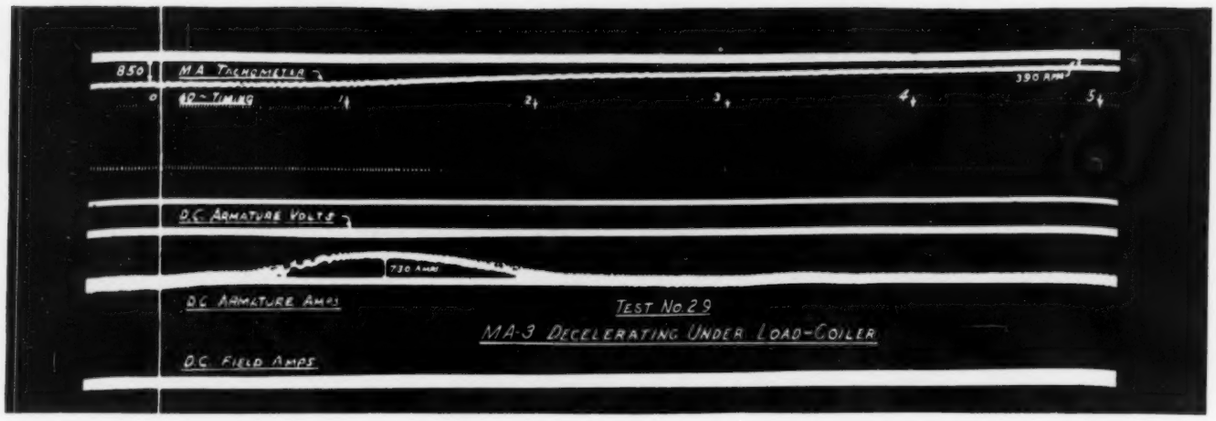


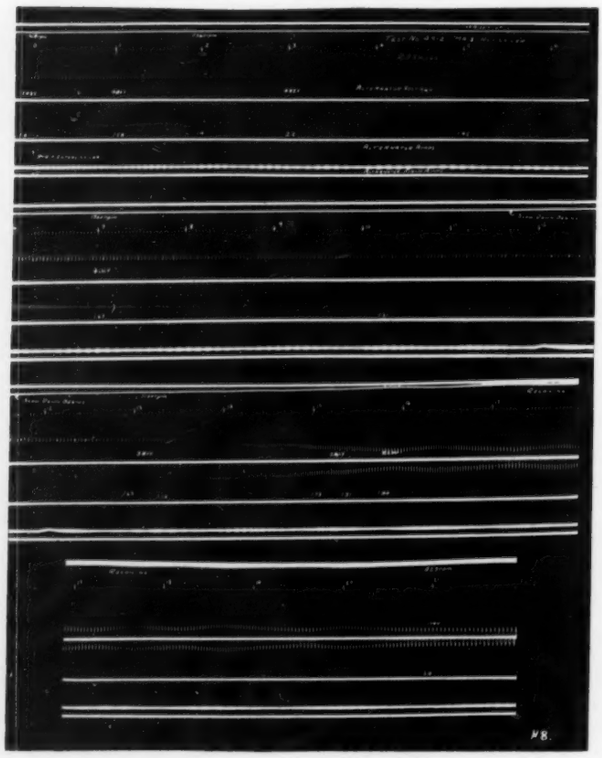
Figure 16—Oscillograph chart of D.C. end of motor-alternator set decelerating coiler.

The input of 6,180 watt seconds for d-c. braking results from the d-c. being left on the motor for 3.42 seconds when it was stopped in 1.3 seconds so that a readjustment of the timing relay cutting off the d-c. braking would still further lessen the d-c. braking input.

Another check of calculated values is made possible by Fig. 20. It is customary for designers to integrate a speed torque curve to predict acceleration or deceleration. Fig. 21 represents the d-c. braking curve of the motors in this chart with individual currents of 26.3 amperes d-c. Integrating this curve in steps of 50 r.p.m. through the conventional formula:

$$t = \frac{WR^2 \times R.P.M.}{308 \times T}$$

Figure 17—Oscillograph chart of A.C. end of motor-alternator set while coiling and decelerating coiler.



and correcting each value of "T" as the square of the 29.7 amperes per motor, shown by Fig. 20, then a stopping time of 1.29 seconds is calculated compared with the 1.3 seconds actual, which is a practical check offering greater assurance in further predictions of a similar nature.

In the same manner from the curve "C", Fig. 22, the plugging time can be calculated and corrected to the actual plugging voltage of 155, thus predicting a 1.76 second plugging time against an actual—Fig. 18—of 1.74 seconds.

Another item that has been the source of considerable concern is the effect on the latter portions of the accelerating period of field forcing. Fig. 18 shows clearly an acceleration to 570 f.p.m. with a study of the a-c. voltage and current. Here then is the information permitting plotting curve "B", Fig. 22, which is the speed torque curve of the runout table motor as affected by the varying voltage produced through field forcing. Integrating the curve "B" then the predicted starting time is 1.43 seconds where Fig. 23 shows it to be actually accomplished in 1.5 seconds. It is especially interesting to note that the effect on acceleration is such that curve "B" and curve "A", Fig. 22, calculate the same accelerating time. In other words, the undervoltage at standstill and the earlier portion of the accelerating period is just compensated for by the overvoltage existing during the latter portion of the accelerating period.

Taking now into account the speed torque curves of the induction motor, the regulation of the alternator and alternator field forcing, with the information gleaned from the tests made for the purpose, an analysis leads directly to the conclusion that at any given frequency, the maximum pounds torque from the motor for minimum rating of 50% power factor alternator is secured when the total theoretical locked kva. of all motors started from one alternator represents 312% of the rated load of that alternator.

Conclusions:

1. The various schemes of operation of runout tables are supplementary rather than competitive.

2. The coefficient of friction of steel strip to conventional table construction is not the same constant at all speeds.

3. Rates of deceleration up to 900 f.p.m. per second seem practicable with d-c. braking.

4. The desirable theoretical locked rotor loading of a runout table alternator is 312%.

5. It is extremely desirable to have overcapacity available in coiler alternator sets.

6. At no greater first cost than for gearmotor drive it now appears practicable to consider direct connecting motors to large diameter rolls and accomplish not only the elimination of this gearing, but have an even more flexible range of control schemes than is now available on the geared table drives.

A brief description of the method in which the Oscillograph tests were made, and the nature of the information which can be secured is no doubt in order at this point.

The oscillograph used is the vibrating element type of which the instrument used had five individual elements. The elements operate in the same manner as voltmeters or ammeters, in that a current passing through the galvanometer causes a deflection of the moving element. In the case of the oscillograph, the moving element carries a mirror which reflects a beam of light onto the film. The magnitude of the deflection of the light beam is measured for a known voltage or current which gives a calibration constant for interpreting the results obtained.

The accuracy of the oscillograph is, therefore, determined by the accuracy of the calibration reference and to the accuracy with which the light deflection on the film can be measured. The oscillograph is essentially not a precision instrument for steady state conditions, but the oscillograph permits more accurate information of rapidly-changing impulses than can be obtained with the usual meters. As an example, we decide from the oscillograph that a certain deflection represents 600 volts. Actually it may be 590 or 610, or even a greater spread, depending upon the magnitude of the deflection. If the voltage is constant we can secure more accurate results with a voltmeter. If, however, the voltage should drop from 600 volts to 300 volts and back to 600 volts in 0.1 seconds, we can determine more accurately with the oscillograph than we could with a voltmeter just what this change is.

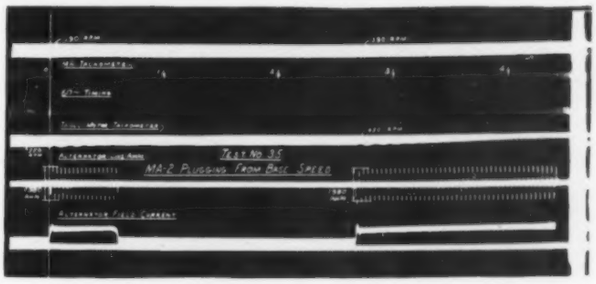
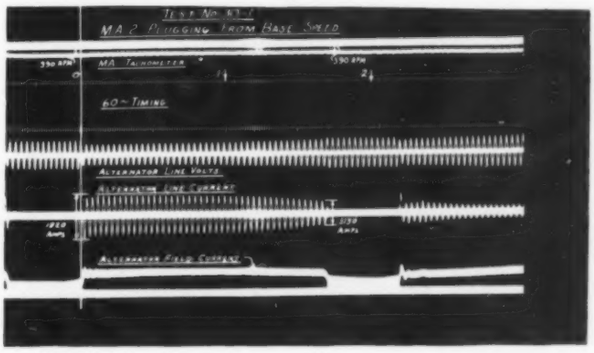


Figure 18—Oscillograph chart of A.C. end of motor-alternator set plugging 68 table rollers from 570 feet per minute.

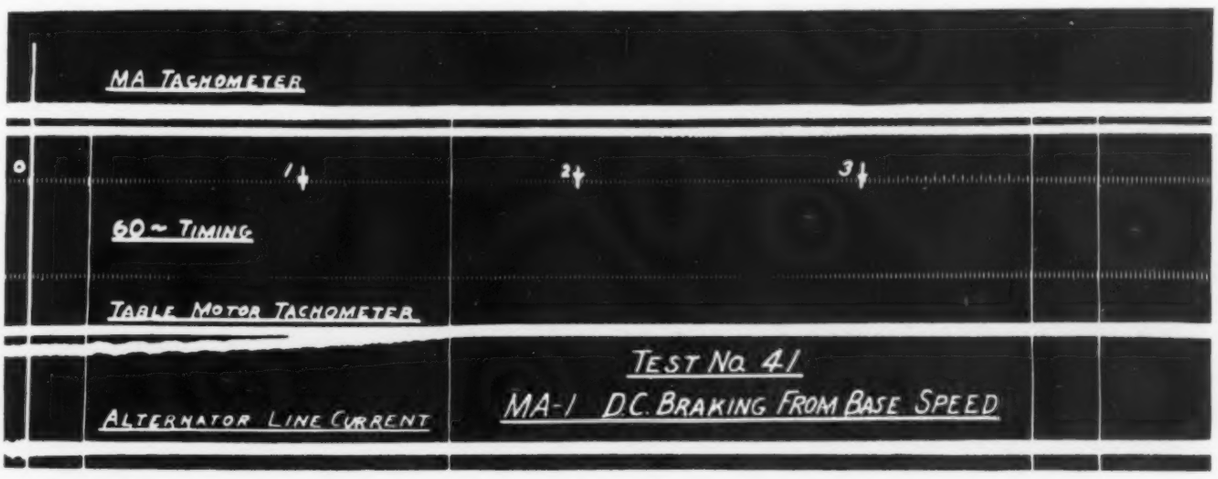
Figure 19—Oscillograph chart of A.C. end of motor-alternator set plugging 68 table rollers from 665 feet per minute.



The oscillograph is, therefore, not best suited for the usual precision performance testing at steady loads. Good meters will give more accurate results .

In making the tests used in preparation of this paper the oscillograph with its auxiliary equipment was set up in the motor room near the control boards. D-c. armature current was measured by measuring the drop along a section of the leads or bus in the proper circuit. The drop required is in the order of 100 millivolts. It is necessary to have a shunt in the same circuit for making a meter reading for calibration. D-c. field

Figure 20—Oscillograph chart of 78 table rollers dynamic braking from 700 feet per minute.



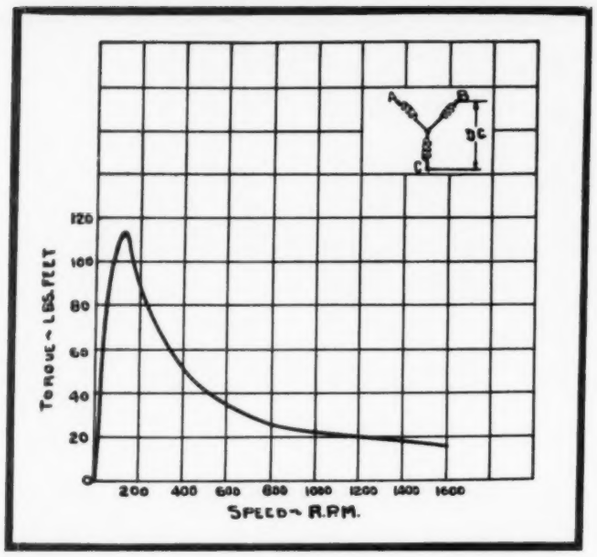


Figure 21—D.C. braking curve (by dynamometer) of six pole run out table duty motor. Frame 324 with 26.3 amperes.

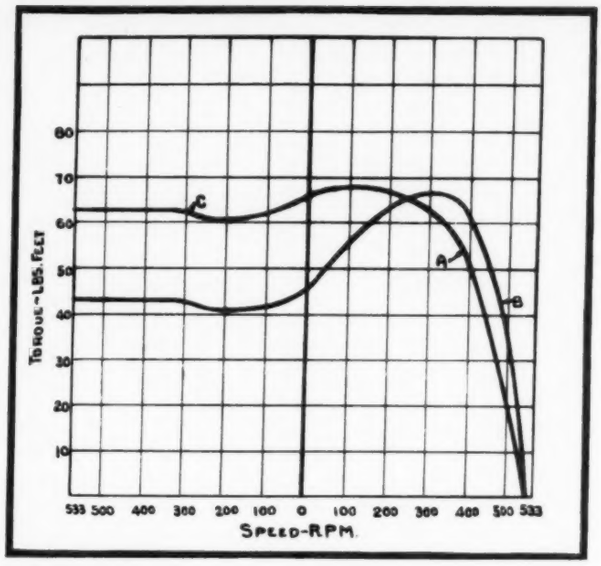


Figure 22—Speed torque curves at 26.6 cycles of six pole run out table duty motor. Frame 324. A—by dynamometer; B—by oscillograph and C—by dynamometer.

currents for both motors and alternators were obtained in the same way. Voltages, both a-c. and d-c., were taken across-the-line in the same way as voltmeter readings are taken. Voltmeters are necessary for calibration.

A-c. current is taken from the usual 5 ampere secondary of a current transformer which is used with the usual a-c. ammeter.

The timing of the film speed is obtained from a known frequency which is impressed on one of the elements. This is usually the potential of the lighting circuit and may be either 60 cycles or 25 cycles, or whatever standard frequency is available.

The speed of the rotating machine is taken from the voltage of a tachometer generator, or the frequency of an alternator may be used.

With the oscillograph set up and ready for operation, it is necessary to know when the operation that is to be studied is going to happen. This was accomplished by means of a signalling arrangement between a man stationed in the operator's pulpit in the mill and the operator of the oscillograph in the motor room. The man stationed in the pulpit told the oscillograph operator when to start the film drive by using a snap switch connected to a light bulb at the oscillograph set up.

The time required to set up the equipment may vary from half a day to a day, depending upon the conditions of the test.

In summary, the requirements of shunts and transformer are the same for oscillograph testing as for testing with the usual meters, since the meters are necessary for calibration purposes.

BIBLIOGRAPHY

"*Individual Drive for Table Rolls*", by W. B. SNYDER, Iron and Steel Engineer, March 1931.

"*Recent Trend in Individual A-C. Roll Table Drives*", by R. M. BAYLE, Iron and Steel Engineer, March 1931.

"*Roll Table Drives*", by F. E. HARRELL, Iron and Steel Engineer, March 1931.

"*D-C. Braking of Induction Motors*", by F. E. HARRELL AND W. R. HOUGH, Electrical Engineering, May 1935.

"*Individual Motor Drive for Runout Tables and Coilers*", by F. E. HARRELL AND C. V. GREGORY, Iron and Steel Engineer, August 1935.

"*Individual Motor Drive for Runout Tables and Coiler Rolls*", by W. B. SNYDER AND L. E. HILDEBRAND, Iron and Steel Engineer, December 1935.

"*Roll Table Equipment for Modern Wide Strip Mills*", by G. A. CALDWELL AND S. F. HENDERSON, Iron and Steel Engineer, December 1935.

"*Problems of Motor Application for Continuous Mill Auxiliaries*", by F. E. HARRELL, Iron and Steel Engineer, April 1936.

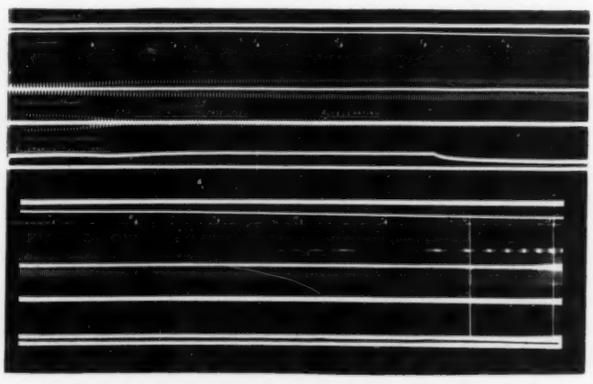


Figure 23—Oscillograph chart of A.C. end of motor-alternator set starting and accelerating 78 table rollers.

DIESEL ELECTRIC LOCOMOTIVES

In Steel Mill Service

By F. H. CRATON
Transportation Dept.
General Electric Company
ERIE, PA.

Presented before the Annual Spring Conference, A. I. & S. E., Buffalo, N. Y., April 28-29, 1937

▲ IN thinking about the diesel-electric locomotives these days, some of us perhaps are inclined to associate it with the glamour of the record breaking streamlined passenger trains, forgetting that in the field of switching work where it made its first big showing, it is going stronger than ever. The Streamliner City of Denver, rocketing over 1048 miles of middle west between Denver and Chicago at the world's fastest schedule speed for a run of this length is a thrilling thing—a sleek, brilliant, yellow and chocolate flash of ultra modern equipment on the fly. But while these trains are out doing their job of regaining passenger traffic for the railroads, the diesel-electric switcher is plugging along in yards and terminals, helping earn the bread and butter, unspectacular, but highly important. Likewise for industry, the diesel-electric is saving money in intra plant switching and transfer work. As a matter of fact, industry frequently has a unique opportunity to realize the maximum advantages of this type of motive power by its exclusive use.

As industrial men and men associated with industrial railroading, you are interested in what the diesel-electric locomotive can do for you, how it can save you money, simplify special problems. This paper will attempt to cover the various features of the diesel-electric that account for its success in switching work and its particular adaptability to solution of industrial switching problems.

660 H.P. Diesel-Electric locomotive in service at the Inland Steel Company, Indiana Harbor, Indiana.

To appreciate the ability of the diesel-electric to do switching successfully, we must understand why a given diesel can do as much work as a steam locomotive of double its rated horsepower. At the risk of repeating something with which many of you may be familiar, this paradox will be reviewed.

Switching work, whether it be railroad or industrial, inherently seldom can utilize much horsepower. Many observations confirm the fact that in freight switching (into which general class industrial switching falls as contrasted with passenger switching) the maximum speed attained infrequently exceeds 8-mph for ordinary loaded moves and 10-mph in kicking moves. Moreover, the average number of cars handled per loaded move is small and the average distance per move, short. For example, during an extended observation period on a large eastern railroad, the average number of cars per loaded move in a freight switching assignment handled by a 6-wheel steam switcher was 4.1, average distance per loaded move about 500-ft. and average speed 4.2-mph.

This composite picture of freight switching is the boiled down result of several types of moves:

1. Light moves.
2. Spotting moves.
3. Pushing moves.
4. Loaded moves.
5. Kicking moves.

Let us consider the comparative performance of a 110 ton, 750-hp diesel-electric and a modern 90 ton, 1500-hp six wheel steam switcher in these various moves.

For the light moves, either locomotive can get from place to place as fast as yard limitations will permit. Likewise for a spotting move and a pushing or bunching

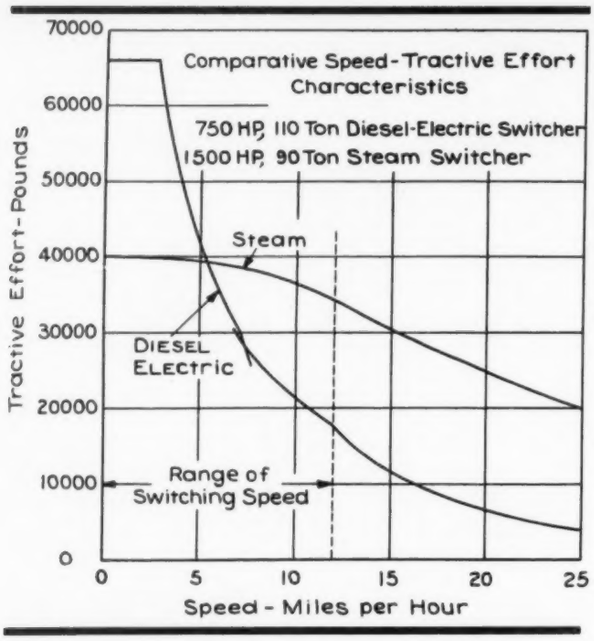


Figure 1—Comparative speed—Tractive effort characteristics of a 750 H.P., 110 ton Diesel-Electric switcher and a 1500 H.P., 90-ton steam switcher.

move, where the requirement is tractive effort and not speed, the diesel-electric will perform the operation as fast as the steam. Also, for an average loaded move or a kicking move involving only a few cars, the diesel-electric and the steam both possess weight and horsepower in excess of what is necessary to make the move as required, the only difference being that the diesel-electric will work at a higher percentage of its capacity.

This leaves only heavy loaded and kicking moves in question. Here both types of locomotives may be called upon to do their best and here only, as far as straight switching is concerned, is the diesel-electric forced to extend itself to equal the steam performance. The diesel has several things in its favor. Due to its swivel truck construction the 110 ton diesel-electric will negotiate sharper curves than and meet the same weight limitations as the steamer with its 90 ton rigid wheel base and therefore, can replace it. The extra 20 tons adhesive weight and the smoother torque of the electric drive means higher accelerating tractive effort below about 5-mph than the steamer. The steamer, although nominally rating 1500 cylinder hp does not develop its full rating until it reaches a speed of about 20-mph whereas the diesel-electric develops its full horsepower from about 3-mph on up through the entire switching range of speed. From standstill up to 10-mph the average driver horsepower of the steamer does not exceed that of the diesel-electric. The result is that up to 5-mph the faster acceleration of the diesel-electric due to its greater driver weight and higher available adhesion balances off what advantage the steamer may have from 5 to 10-mph. Due to the maximum speed being limited to 8 or 10-mph, the steamer never can get up to speeds where its greater horsepower would allow it to walk away from the diesel. See Figure 1.

There are a few other factors which enter this picture but do not materially change it. Due to the steamer having the tender to brake with in addition to the locomotive proper, the braking of the steamer is somewhat more effective than the diesel-electric. The fact that the tender brakes, to be safe, should be based on the light weight of the tender and that the diesel-electric weighs more than the steam locomotive alone, tend to bring the braking rates very nearly in line. Moreover, the tender when loaded is a constant burden on the steamer since it may be equivalent to approximately one extra car over the diesel-electric's gross weight. Whereas, the diesel has its full horsepower constantly available, the steam locomotive may not have its full power ready for action depending upon the steam pressure and condition of the fire; in fact, the tendency frequently is to run a low fire to avoid excessive popping off during the large portion of total switching time that is spent with the throttle closed. In many typical switching assignments, this so called "idling" time is in the neighborhood of 70% of the total assigned time.

In the transfer service which is sometimes incidental to a switching assignment, the steam locomotive has a better chance to out-perform the lower powered diesel-electric providing higher speeds are permissible than in the switching. Actually this seldom is much of a handicap to the diesel since the percentage of total assigned time in this kind of transfer work is small and unless some unusual grade condition exists, both the diesel and the steam will haul the trains involved at the desired speed, the only loss of time being in the total acceleration, which again may be a small portion of the transfer time, and an insignificant portion of the total time.

In actual practice, where 600-hp, 100 ton diesel-electrics have replaced six wheel steam switchers, almost invariably their performance is judged by the railroad men to be faster than the steam. One immediate manifestation of this is the deep satisfaction the engineer expresses for his new found ability to "run the pants off" the ground crew.

The first diesel-electric switcher in the United States was a 300-hp locomotive on the Central Railroad of New Jersey in 1925. At present there are some 250 odd diesel-electric locomotives in switching service in the United States. (See Fig. 2.) Most of these range in size from 300 to 1000-hp and 50 to 125 tons. The majority of switchers being built today are either 600-hp, 100 ton units for replacing 6 wheel steam switchers or 900-hp units of 115 to 125 tons for replacing 8 wheel steam switchers. These may be regarded as more or less standard sizes although there are a variety of other weights and horsepowers available.

The greatest advantage of the diesel-electric switcher is its economy and when applied in a service where it has a high utilization factor, the savings it will produce over steam operation frequently net a substantial return on the investment. It is not claimed that the substitution of the diesel for steam is always economically sound. Too much depends on the number of hours per year the diesel can be worked and the status of steam equipment to be replaced to jump at any hasty conclusions. However, where service exists that

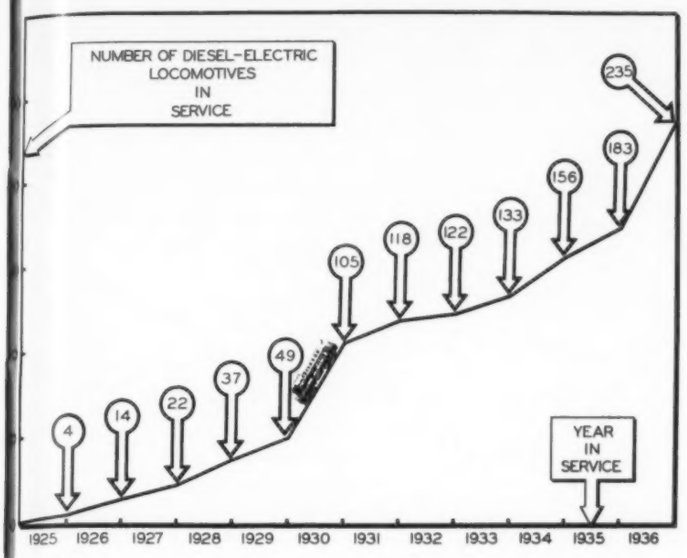


Figure 2—Number of Diesel-Electric locomotives in service, 1925–1936.

can utilize locomotives 16 to 24 hours per day and where existing steam equipment is pretty well written off or new equipment is contemplated, any operator may be passing up a distinctly good bet by failing to investigate carefully the use of diesel-electrics. There are many diesel-electric locomotives earning from 10% to 20% on the investment after deduction of fixed charges and some even more. There are very few places these days where money can do as well as that.

Briefly the principal reasons for the economy of the diesel-electric as compared to steam are:

(*a*) One man operation, saving about 45% of crew expense on many industrial applications.

(*b*) High overall efficiency saving from 70% to 50% of cost of fuel.

(*c*) Lower maintenance saving approximately 50% of repair cost.

(*d*) Negligible amount of water required, saving practically 100% of water costs.

(*e*) Because of absence of boiler and firebox, relatively little enginehouse expense, saving 50% or more on this item depending on extent of diesel application.

The net result of these combined savings after allowing for the lubrication expense of the diesel being about 100% greater than for steam often is a saving of approximately 50% in the operating and maintenance cost.

A representative comparison of operating costs of steam and diesel-electric switchers is shown in Fig. 3. Admittedly costs vary widely in different situations depending upon cost of coal and labor, quality of facilities, number of locomotives, etc., but generally speaking the approximate ratios indicated hold good in the majority of applications.

The old jinx of the diesel-electric was its high initial cost and consequently high fixed charges which made serious inroads on its operating economies. Today, diesel-electric locomotives cost from 30% to 40% less than locomotives of the same weight and horsepower ten years ago. Moreover, the locomotives of today are better locomotives embodying many improvements promoting greater efficiency, better utilization of power and weight, simpler, more reliable, less costly to maintain. It is to the credit of the diesel-electric that in spite of the high initial costs of several years ago, the units purchased then have already paid for themselves in savings. Today, with lower fixed charges, the diesel is far more attractive as a sound investment.

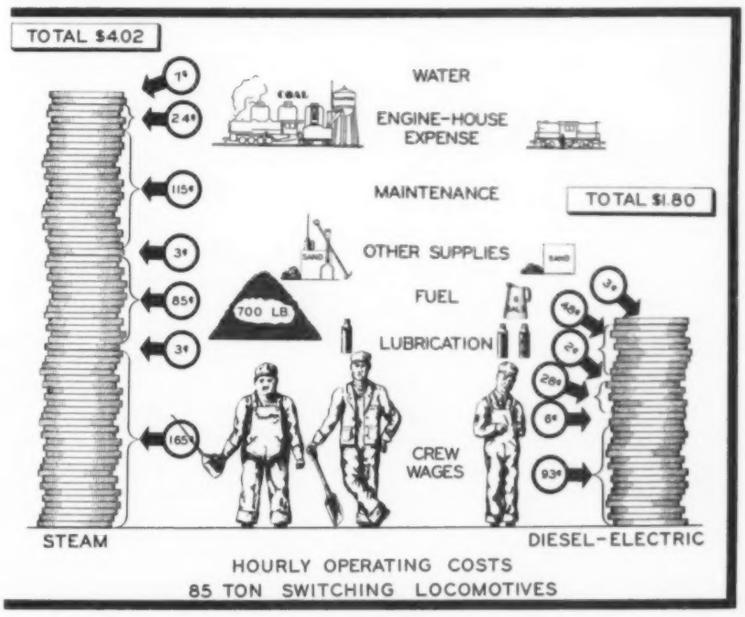
For example some 1000-hp, 125-ton switchers were recently sold for less than the same operator paid for a 600-hp, 100-ton unit several years ago—67% more power, 25% greater weight for less money.

One of the outstanding features of modern diesel-electric locomotive design is the extensive use of standard steel mill products such as plates, shapes, sheets, bars, etc., throughout the entire mechanical and electrical assembly by the fabrication of parts by electric welding. This type of construction results in shorter locomotive shipments, greater reliability and lower costs, and in cases where low weight is important, valuable weight reductions.

One of the outstanding advantages of the diesel-electric is its high availability and this is of importance from the viewpoint of fixed charges. Taking a reasonable availability of 60% for the steam switcher and 85% for the diesel, realizing that there are both types in operation in some instances with somewhat higher factors, it is obvious that in most applications it requires fewer diesels to do a given job than steamers. Just what the ratio is depends upon the nature of each application, but the tendency is to reduce the adverse comparison of diesel fixed charges against steam. On one road the availability of locomotives during a period represented by 292,000 service hours and covering seven years was 86.7%.

Some of these older diesel-electric switchers have made astonishing records. One 300-hp, 72-ton unit in industrial switching has run 45,000 hours without re-

Figure 3—Comparative hourly operating costs—85-ton switching locomotives.



moving an engine head and it is still running and doing a good job. We think of our automobile engine as doing remarkably well if it runs 50,000 miles without the head coming off and yet that represents only three or four thousand hours at most. This diesel has run more than ten times as long.

Heavy industry operating its own intra plant railroad systems has a rare opportunity to capitalize fully on the advantages of the diesel-electric. It is only by complete dieselization just as by complete railroad electrification that the maximum return on the investment is realized. Although the diesel-electric is an excellent investment for the Class I railroads, they are not in a position to realize its maximum benefits because they cannot at present economically dieselize 100%. The steam facilities must be largely retained for the steam locomotives in road service for example, but in an industrial plant, where the motive power equipment is used exclusively in intra plant work involving switching and short transfer runs and if a high utilization of locomotives is possible, it is practicable right now to supplant steam entirely. Then the ultimate savings are realized as a result of drastic cuts in enginehouse expense, elimination of coal, ash handling and water facilities, elimination of turn tables, reduced building and track maintenance. Industrial plants with their own intra plant railroad systems where locomotives can be utilized in two and three shift service are in a position to cut their locomotive operating and maintenance costs from ⅓ to ½ by such a program.

While operating economy is the most arresting advantage of the diesel-electric, it has other advantages worthy of consideration. For example, the smooth torque of electric drive renders the locomotive easier than steam on any track, but in an industrial plant where so much curvature is bound to exist, this advantage is supplemented by the reduced track wear due to swivel truck construction with short rigid wheel base. No specific savings have been claimed for this because to date it has been hard to evaluate but it is a definite factor in relative economy. Swivel truck design also has a marked effect on relative flange wear between steam and diesel, an item in reduced locomotive maintenance. Due to the fact the diesel-electric will work with equal facility in either direction, it may be turned around periodically to equalize what flange wear occurs. Still another advantage of the swivel truck with its flexibility and short rigid wheelbase is a reduction in derailments.

The absence of flue gases and heavy smoke in the diesel means reduced maintenance cost for interior and exterior of buildings, under sides of trestles and subways, cleaning of mill windows and electric light fixtures. Take the General Electric plant at Erie, where steam locomotives have seldom come in close proximity to the buildings because electric or diesel-electric locomotives have always been used. Although parts of the plant vary from twenty-five to five years old, all buildings, which are of the same type of architecture, are of such uniform cleanliness, it is next to impossible to tell the age of a building by its appearance. They all look inside and out very nearly as new as the day they were finished. One exception—the foundry; the interior of that looks pretty tough, but even that illustrates the point.

There are many industrial plants that have grown and spread out and the ingrown still more within confined areas, resulting in particularly congested railroad trackage conditions with much curvature and many extremely sharp curves. These conditions are serious handicaps to the use of larger steam locomotives even though expansion of business demands more power to handle the work expeditiously. The diesel-electric, however, is not handicapped by such conditions because, due to its swivel truck construction, even the larger sizes can negotiate sharp curves without difficulty. Such units can go in and speed up production without demanding expensive or sometimes impossible changes in track layout.

One steel mill now undertaking a change-over to diesel-electrics, found that a 1000-hp, 120-ton diesel would go over present bridge structures that would not carry an eight wheel steam switcher due to concentration of weight of the latter. Where they had been using a six wheel steam locomotive to do a certain job over these tracks, they substituted the 1000-hp, diesel-electric and cut the number of trips per shift in half, something that would have been impossible with steam without prohibitively expensive changes in the bridges involved.

Due to the excellent visability of the diesel-electric and the ability to operate from either side of the cab where desirable, operators find that considerable time is saved by elimination of relaying of signals from the ground crew through the fireman to the engineer. Locomotives are available in which the operator has instant control of throttle and brake valves from either side of the operating cab, which is valuable in congested areas among buildings where the visibility shifts on short notice from one side of the track to the other. These features mean faster and safer switching.

It is beyond the scope of this paper to discuss the economies of the diesel-electric as applied to specific jobs. Nor is it possible to state definitely just what size diesel should be used to replace a given steam locomotive. These are things which individual situations and conditions dictate. Suffice it to say that diesel-electric locomotives are available in a variety of sizes from small 25 ton, 200-hp units on up to units of 125 tons and 1000-hp or even more, modern designs adapted mechanically and electrically to the work to be done.

This paper has not presumed to sell the idea that the diesel-electric locomotive is the answer to all industrial railroading problems. From a strictly engineering viewpoint, it is superior to steam in this class of work. Efficiency, flexibility, low maintenance, availability, low operating cost—in these things unquestionably it excells. But it must be used, its high availability must be taken advantage of. The progress being made in reduction of the initial cost of the diesel-electric through better manufacturing methods, larger production, more efficient use of material, simplification, is however, rapidly widening the field of economical application and without much doubt the next few years will see many of the larger industries operating their own intra plant railroad systems 100% with the diesel-electric. It is the right way, the modern way. If, for those of you who are not already "diesel-electric minded", this

paper will arouse or renew your interest in the investigation of this useful tool for your work, it will have achieved its purpose.

DISCUSSION

PRESENTED BY

W. A. MARSHALL, Superintendent of Construction, Carnegie-Illinois Steel Corporation, Irvin Works, Dravosburg, Pa.

O. NEEDHAM, Engineer, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

C. C. BAILEY, Transportation Dept., General Electric Company, Schenectady, N. Y.

A. J. STANDING, Electrical Superintendent, Bethlehem Steel Company, Bethlehem, Pa.

F. H. CRATON, Transportation Dept., General Electric Company, Erie, Pennsylvania.

W. A. MARSHALL: There is a question that rises in my mind when comparing Diesel locomotives with steam locomotives; that is, when you have a cheap fuel available in coal, which costs about $2.00 a ton, particularly in the Pittsburgh District, would it pay from that viewpoint to go into the Diesel locomotive?

O. NEEDHAM: Some time ago I had occasion to make a study of this question. At that time we had very little experience with the operation of Diesels, and practically none with their use on steel mill switching. We did have some maintenance data on the use of Diesels on the main line of the Canadian National Railways. We had to arrive at our figures on maintenance and so forth from our little experience on these main line drives. I believe the figures given by Mr. Craton here are considerably better than the figures we arrived at, at that time on the question of maintenance and operating cost.

Mr. Craton has been quite conservative in his statement of the case for the Diesel engine, and as he has said, it is sometimes difficult to justify the replacing of a good new steam locomotive with a Diesel, but if it is necessary to purchase a new unit of some kind, I believe a study of all cases will show that the Diesel is much the better investment.

C. BAILEY: I should like to add emphasis to one of Mr. Craton's remarks—that industrial plants have a wonderful opportunity not available to railroads—to take full advantage of the economy of Diesel electric switching by a complete replacement of steam switching power with their associated operating and maintenance facilities.

The railroads have certain handicaps in this direction: First, maintenance and repair facilities must be retained to take care of road locomotives so that their savings in the use of Diesel electric power are in general dependent upon operating costs rather than a full realization of lower maintenance costs although where accurate accounting is available, the latter are reflected even under this handicap. The Boston & Main annual report for 1936 published a few weeks ago illustrates this point. I quote:

> "Three new 600 horsepower Diesel electric switching locomotives were purchased and placed in service in the Boston Terminal the first of September and, as a result, have reduced both labor and fuel costs in this switching district. Five such units are now in operation and have not only reduced operating costs but due to their continuous use over the entire 24-hour period have displaced a correspondingly greater number of old type steam locomotives with high maintenance costs."

Another handicap is a matter of depreciation accounting. Rates for some of the larger companies vary from 2.7 to 4%. In the latter case, the cost of a steam locomotive is amortized over a period of 25 years. If it is replaced by a Diesel electric before that time, the new locomotive must absorb the unliquidated depreciation account of the older locomotive.

The other handicap is perhaps the most difficult. In an effort to provide faster and more economical motive power for freight and passenger service, large sums are being expended and are showing a splendid return on the investment. This carries with it a temptation to assign and convert the displaced road locomotives into switching power because it is apparently an easy way to avoid the depreciation write-off—at the moment.

Without these handicaps, you do have a real opportunity in being able to make a decision on the matter of completely changing your switching power to Diesel electrics with the definite assurance that you can make the greatest possible return on your proposed investment.

A. J. STANDING: Mr. Craton's paper has been quite interesting. I don't think it has overstated the mark particularly.

Our experience at Bethlehem started prior to 1929. With a 60-ton battery locomotive to which we added an experimental Diesel engine. 1929 came and went and, to use a poetic expression—then came the depression. While the steam locomotives proceeded to grow older, no one did very much about it temporarily. However, we continued experimenting with the 60-ton Diesel locomotive, using it in the various standard pulls in and about the plant, which gave us a fairly comprehensive working knowledge of what that Diesel could and would do.

Later on, in about 1933 or 1934, we began to go into the problem of locomotives quite seriously, due to the fact that the steamers which we had then had been

somewhat sidetracked, and had been affected by the normal obsolescence and old age, and the problem of replacing them was quite pertinent, with the result that today we have at Bethlehem six Diesel units, ranging from a 60 ton, about 150 or 160 horsepower unit combination Diesel battery electric to a 900 horsepower 100 ton straight Diesel unit.

Our largest and hardest pull has been what we call the blast furnace pull, which involves pulling the slag pots from the blast furnace to the cinder dump and hauling the hot metal submarines from the blast furnace to the ingot mold foundry and the various open hearth departments. The Diesels have qualified in that service, that being rather the test run which they had to make to prove their value in our service.

From a maintenance standpoint, the experience with the Diesel has been roughly on a cost basis of probably $10.00 to $11.00 an hour for steam as against roughly $7.00 to $8.00 for Diesels, a saving of approximately $3.00 an hour in favor of the Diesels.

That saving has been made up in part by the elimination of the firemen, and to a large extent in maintenance cost which has amounted to roughly $1.30 or $1.40 an hour, and the balance of it is in fuel and water.

We are not prepared to say that our mind is made up definitely on Diesels, but I think we are very rapidly coming to the point where we consider ourselves quite well sold. The Diesels are doing a good job. We are becoming more familiar with them. The maintenance of the units has been on a predetermined, prescribed basis. We have acquired a man with some degree of skill in the handling of Diesel units, and above all, I think we have somewhat reached the point where we have quit experimenting with fuels. That, to begin with, was quite a serious problem, and we had to take our grief like everybody else before we got down to a standard No. 2 Diesel fuel oil, which has not only seemed to account for better operation but it certainly accounted for improved maintenance.

So much for that side of the picture. Now from the Diesel manufacturer's standpoint I would like to make a plea that they begin to work on my old subject of standardization, that they cease trying to crowd too much equipment in where only the builder can put it and where the maintenance man is lucky if he finds it sometimes. They should get together at this stage of the game, and if possible standardize electrical equipment, standardize generators, standardize your control and your motors, if you please. That would then eliminate the necessity, which we may find ourselves forced into, of buying duplicates in order that we may have some reasonable spare part assurance to keep them going. The diversification is going to force us into some such move as that.

The control equipment is similar I think to the old installations in battleships, where the electrical equipment had to be installed in turrets. Years ago, when I worked in the electrical maintenance game, if you didn't bump your head every time you looked for something, you were lucky. The electrical equipment of locomotives is somewhat similar. It of necessity has to be compact, I grant you that, but our boys sometimes think it can still be compact and be a little more accessible. I think a little more care from that standpoint will help us all.

By and large, I think we are prepared to say that our experience so far, with six Diesels in the plants which we service, has proven that they are here to stay in that service. It has involved little or no major track changes. There were a few slight improvements which were necessary. The clearances in buildings and parts of the plant have not been affected to any extent. The abatement of smoke nuisance is buildings has been considerably improved because it seemed to be characteristic of steam engines that they had to do their blowing every time they came into a building, and it was about half an hour before the atmosphere cleared up. There has been quite an improvement, and it has also been an improvement about the yards. The general condition of the yards is better.

We don't want to be too enthusiastic. We have been very slow in being converted on this subject, but we think they have a place.

F. H. CRATON: The question raised as to whether or not a diesel-electric locomotive would be economical in an application where $2. coal is available is a good one, and brings out one point which the paper attempted to make. It is not advisable to jump at the conclusion that diesel-electric application is always economical. It may or may not be depending upon the nature of all factors involved, and all factors should be weighed before making a decision.

As fuel saving is one of the major items in determining diesel-electric economy, a case where $2. coal is involved merits careful consideration of the influence of this factor in total economy. Taking coal at $2. per ton and fuel oil at 5 cents per gallon, and assuming a ratio of 100 pounds of coal burned to 1 gallon of fuel oil consumed in the diesel-electric for the same work, which is a conservative estimate, the fuel saving with the diesel-electric would be 50%. What this would be in dollars and cents would be the important factor and would depend on the amount of work done. This saving then would have to be weighed along with others, and the total savings balanced against the fixed charge set-up to determine the advisability of applying diesel-electrics. Although $2. coal is an adverse factor as far as the diesel-electric is concerned, it does not mean necessarily that diesel-electric application would prove uneconomical. It should take its place in the whole economic picture and play whatever part its influence dictates.

MODERN STEAM TURBINES

In Steel Mills

By A. G. DARLING
Industrial Dept.
General Electric Company
SCHENECTADY, N. Y.

Presented before the Cleveland District Section of the A. I. & S. E., November 20, 1936 and the Chicago District Section, January 5, 1937

▲ BRIEFLY, this paper will describe how typical turbine-generator power plants of the steel industry have been designed in the past ten years, the changes that have occurred, and some of the advances which are available for new plants.

Figure 1 shows the growth of steam turbine generator use in the steel industry. Up to 1927 the use of turbine generators had not been extensive. In 1927 there was a general expansion both in the number and in total kilowatts of installed capacity. From then on to 1935 there was no need for more capacity. More recently, activity has begun again and it is interesting to see how the features of design have changed, if at all.

Figure 2—Maximum Steam Pressures and Temperatures contrasts the trend in the steel industry with the general trend, the chief points of comparison are pressure, temperature and rating at the throttle.

While the output of any single unit is a matter of local conditions, the trend toward higher pressures and temperatures is independent of the rating, with the preponderance of larger ratings being built to take advantage of the expansion in heat range made possible by the development of materials and design which have been found suitable for such use.

A. G. DARLING

In 1923, the Philo and Crawford Avenue units used re-superheating to offset the moisture obtained by expansion from 600 lb. and 725°. These two are examples of about two million kilowatts of turbine capacity in this country.

Boston followed by Milwaukee, adopted 1200-lb. turbines of the non-condensing, superposed type, and again resuperheated before discharging into station mains. Condensing turbines of the same initial pressure followed, but also used resuperheating at suitable points in the flow.

More recently the use of resuperheating has been decreasing. This is because of the attainment of materials suitable for 925° temperature, which tends to reduce the moisture content in the latter stages of the turbine. Incidentally, two out of every three of the twenty-five large turbines ordered during the past year in this country are of the non-condensing type discharging their steam into existing boiler mains for later use in other lower pressure turbines for process, for steam engine or turbine blower use, or for building heat and feed water heating.

Undue emphasis need not be placed on the adoption of the highest pressure and temperature available. The well balanced heat-output cycle will consider the usable amount of steam, the desirable amount of power to be obtained, and arrive at such initial steam conditions as will give these quantities of low pressure steam and kilowatt output. This investigation may result in the maximum initial conditions but is likely to show that some more moderate conditions will serve the purpose to better advantage. For example, after consideration of a number of alternatives, two steel companies found that 800-lb., 800°F. in one case and 400-lb., 700° in the second case suited their requirements. Still another industrial recently specified all the conditions, including the desired output, but requested each manufacturer to state the lowest initial pressure his efficiency of turbine would permit.

Figure 3—Typical Modern Turbine Generators, illustrates the designs recently ordered by utilities and industrials and bears out the contention that the trend in initial heat is upward but is modified by the local requirements.

3600 Rpm. machines of about 7500 Kw. rating and less have been built for many years. Of

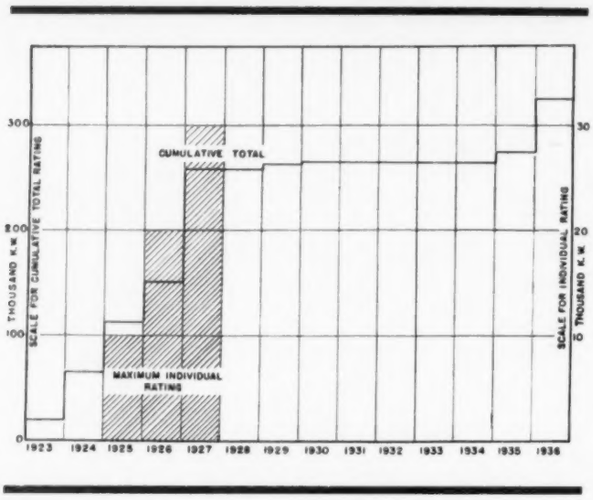


Figure 1—Growth of steam turbine generator use in steel industry. (General Electric Units only.)

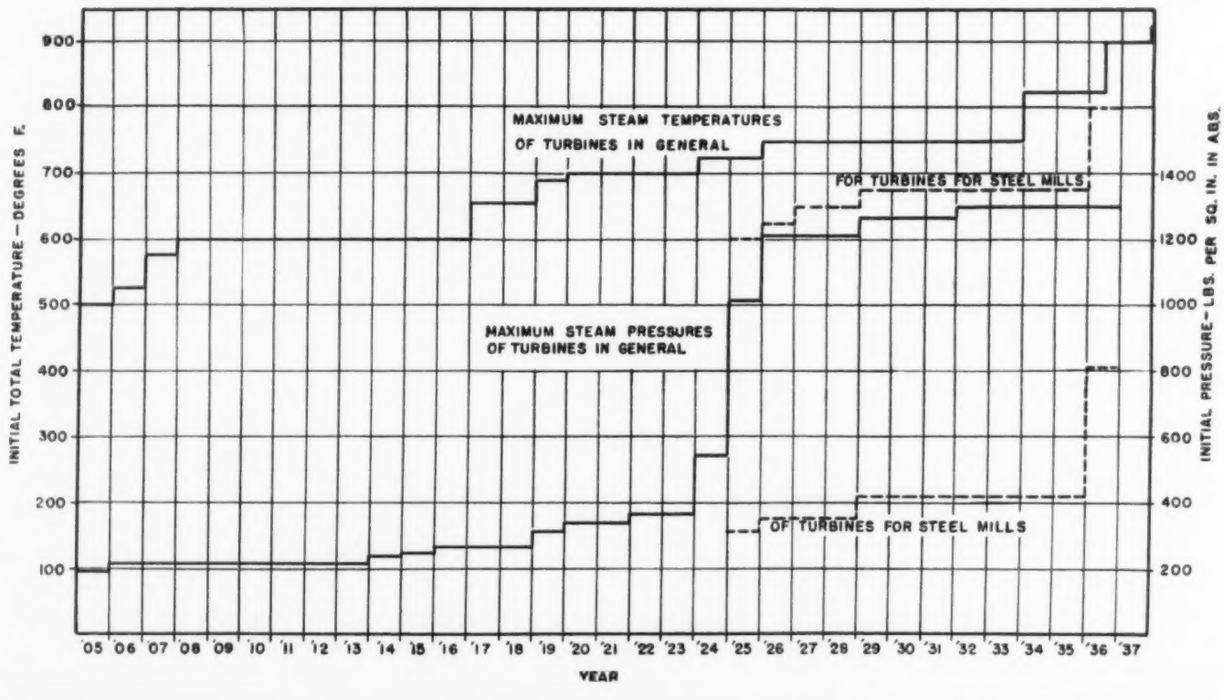
the larger ratings, the first 10,000 Kw., 3600 Rpm. machine was put in service in 1930; a 12,500 Kw. in 1931; a 15,000 Kw. in 1934. At present, a 25,000 Kw. condensing type, a 25,000 and a 40,000 Kw. non-condensing type, and two 66,667 Kva. at .9 P.F. are being built all at 3600 Rpm. The last two mentioned will use hydrogen as a cooling medium. The increase in peripheral speed over the period from 1906 to 1931 was from 472 to 1202 feet per second. The two 160,000 Kw. Brooklyn Edison Co. units operate at the latter peripheral speed.

Creep-strength is perhaps the most important characteristic of steel for high temperature. The increase in this respect is illustrated by Figure 4—Progress in Creep-Strength of Turbine Materials.

For turbine design, the curves represent the advances made in the characteristics of different steels containing materials such as nickel, chromium, molybdenum, manganese, etc., for such purposes as rotors, shells, nozzles, buckets and bolts. The coordinates represent strength at various temperatures. Research and testing continues in order that the best material available can be found. Long life tests are required to prove the materials.

Turbine shells, such as shown in Figures 5 and 6, are designed to keep the distortion within safe limits using shapes that will not suffer from contraction or expansion. The large single cylinder, non-condensing turbines for temperatures above 900 degrees have double shells. The space between the shells is filled with leakage steam at considerably less pressure and temperature than that in the inner space. The outer shell is at a lower temperature than the inner and the pressure across the inner sheel is much less than if it took the entire stress. Being subjected to steam on both surfaces, it warms up more evenly and therefore at a faster rate than is used for single shell designs. Steam is distributed through nozzles fed by relatively flexible pipes and control valves from a common manifold or header below the turbine floor. Two control valves admit steam to this header. Below the floor at the generator end are located the oil pumps and tanks away from the high temperatures of the steam end.

Figure 2—Maximum steam pressures and temperatures.



The high pressure oil piping is enclosed in the low pressure return lines so leakage from the high pressure is collected in the lower pressure area.

The solid forged rotors of turbines for 1800 and 3600 Rpm. at 50,000 Kw. rating are shown in Figure 7. The wheels are integral with the shaft, having been machined from a single forging.

Ductile weld metal is used to unite the complicated parts of fabricated nozzle diaphragms (Figure 8). Uniformity, smooth side walls and guide surfaces are attained with high strength.

Work on hydrogen cooling of turbine-generators has progressed since 1922 when a 3380 Kva. unit was operated at the factory. A commercial unit was built in 1928 for this service. Based on those experiences and on the data secured from hydrogen-cooled synchronous condensers, a 50,000 Kva. unit was designed in 1935 for Logan Ave. For the higher pressures, 3600 Rpm.

FIGURE 3

TYPICAL MODERN TURBINE-GENERATORS

CONDENSING TURBINES—UTILITIES

	KW Rating	Purchaser	Initial Pres.	Temp.	B.P. In Abs. or Lbs. G.	RPM
	150,000	Chicago Dist. Elec. Gen. Corp.	1200	825	1"	1800
	55,000	New Jersey Power & Light Co.	1200	725	1"	3600/1800
(2)	55,000	Pacific Gas & Elec. Co.	1250	750	1"	3600/1800
	53,000	American Gas & Elec. Co. Deep Water	1200	725	1"	3600/1800
	53,000	American Elec. Power Co. Deep Water	1200	725	1"	3600/1800
	25,000	Jersey Central Power & Light Co.	1250	750	1"	3600/1800
	75,000	Union Electric Light & Power Co.	315	725	1"	1800
(2)	60,000	Detroit Edison Co.	600	825	1"	1800
	35,000	San Diego Consolidated Gas & Elec.	235	725	1.5	1800
	25,000	Public Service of Colorado	350	675	1.	3600
	20,000	United Power Mfg. Co.	825	825	1.5	3600
	10,000	City of Hamilton, Ohio	325	630	1.5	3600
		INDUSTRIALS				
	110,000	Ford Motor Company	1200	725	1"	1800
	110,000	Ford Motor Company	1200	900	1"	1800
(2)	20,000	Jones & Laughlin Co.	410	614	1"	1500
		NON-CONDENSING TURBINES UTILITIES				
	12,500	Virginia Elec. Power Co.	825	825	220#	3600
	60,000	Ohio Power Co., Windsor	1250	925	235#	3600H.
	60,000	West Penn. Power Co., Windsor	1250	925	235#	3600H.
	40,000	Appalachian Elec. Power Co. Logan (Am. G. & E. Co.)	1250	925	200#	3600H.
	25,000	Dayton Power & Light Co.	1200	900	230#	3600H.
	25,000	Monongahela W. Penn Pub. Service Co., Riresville	1200	925	260#	3600
	10,000	Nebraska Power Co., Omaha	1200	900	190#	3600
	10,000	Consumers Power Co.	750	850	210#	3600
		INDUSTRIALS				
	15,000	Ford Motor Co.	1200	900	250	3600
	10,000	Firestone Tire & Rubber Co.	1250	750	235#	3600
	7,500	Goodyear Tire & Rubber Co.	725	720	100	3600
	10,000	Diamond Alkali Co.	725	800	150	3600
	10,000	Weirton Steel Co.	800	800	225	3600
	7,500	Youngstown Sheet & Tube Co.	400	700	150	3600

H = Hydrogen Cooled.

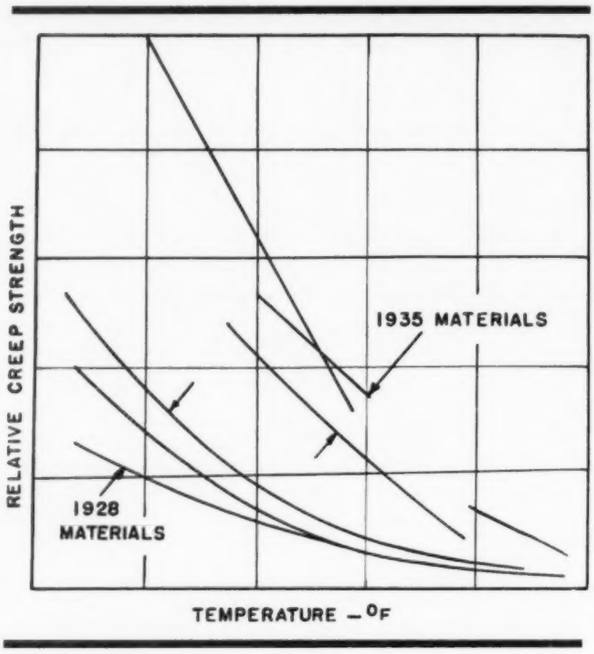


Figure 4—Progress in creep strength of turbine materials.

is desirable and the rating of the generator can therefore be increased within allowable strength limits if hydrogen is used as a cooling medium. Figures 9 and 10 show the casings of a 31,250 Kva., 3600 Rpm. generator. Fans on the rotor circulate the hydrogen through the generator to tube coolers mounted in the radial space within the outer shell.

A paper dealing with present-day turbine design would leave the reader somewhat at sea if nothing were said as to the availability of reliable equipment to supply the turbines with clean steam, of pressure and temperature such as will secure the desired economies. A review of the success obtained in operation, as well as a study of published material and permissible standards, lends confidence to the future success and further expansion in the range of recoverable heat energy. The importance of turbine-generator design is in no way submerged when close attention to the design, construction, operation and maintenance of the steam supply, fuel burning, steam condensing, feed water treating and heating is suggested. Industrial plants offer even more of a problem to the power plant engineer than do those plants whose output is entirely electrical and whose steam systems can be carefully guarded against introduction of impure feed water.

Boiler manufacturers are prepared to offer and have put in successful operation steam generators which will supply the turbines with usable steam at conditions higher than 1200-lb., 925°, and state that they are ready to increase these figures. Availability factors of such units now compare favorably with those of the turbines, which suggest the possibility of using unit boiler-turbine installations—especially when less efficient lower pressure boilers and turbines are not discarded to admit the more efficient high pressure additions. Boiler pressures of 1800-lb. and (not simultaneously) total temperatures of 1000°F. have been attained in practical cases. Low carbon steel alloyed with 0.25 to 0.60 percent of molybdenum, approved by the Code, increases the yield point and results in a plate for drums which can be more readily bent to cylindrical form.

Steam washers are quite commonly used because of their successful reduction of the deposits of solids on turbine blading. Feed water having a low concentration of solids is used as a washing medium, taking the place of the moisture in boiler steam, usually high in concentrate, which was previously carried over to the turbine.

Superheat temperature, a variable with boiler loading, is now controlled by intermediate de-superheaters or by by-passes and dampers. At steam temperatures between 900 and 950°F. the limit of available superheater tube material in the low alloy, medium price range is closely approached and it becomes increasingly important that the steam generating unit will result

Figure 5—Inner and outer lower-half shells assembled for G-E steam turbine.

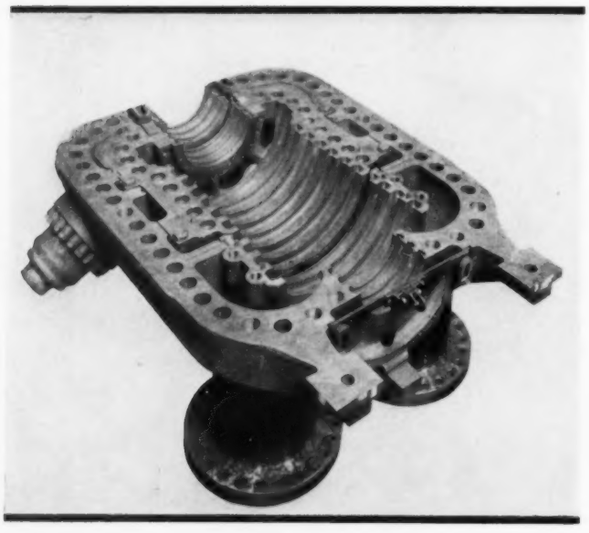
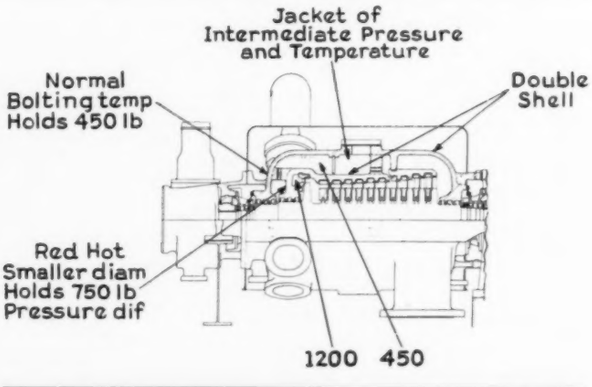


Figure 6—Double-shell high-temperature and pressure steam turbine-longitudinal semi-section.



in an even distribution of gas flow and gas temperature over the superheater and of steam flow through the superheater elements so that the temperature of the elements will not vary excessively from the mean for which the superheater is designed. Chrome-nickel or chrome-molybdenum steels for temperatures above 850°F. take the place of carbon steel tubes for lower temperatures.

When a large portion of boiler steam is not returned in a closed system to the boiler, the problem of sufficiently pure water to insure high continuity of service becomes a major one. Some plants use evaporators which become heavy space consumers when a heavy proportion of the feed supply comes from raw water. Other plants have had success with feed water treatment even to the extent of 100% raw water make-up.

Whether the boilers are to operate on feed water consisting practically completely of treated make-up, or on condensate and evaporated make-up, certain conditions requisite for either case must obtain. One of these is complete deaeration,—modern deaerating heaters effecting the removal of all but a very minute fraction of oxygen in the feed water, and chemical fixation removing the remainder by one of the sundry chemicals which readily combine with oxygen, and thus complete its removal from the feed water. Another of these is an adjustment of pH value of the feed water so that it will be inhibitive of corrosion of boiler feed lines, boiler feed pump and its impellers, economizers, and stage heaters. A satisfactory pH value may result from the character of the treatment, or it may be essential to build it by the addition of alkali either directly from a supply tank, or by controlled recirculation of the alkaline boiler water. On the basis of the pH value of the feed water, the pump manufacturer chooses the metal which will go into the feed pump. In the boiler water itself, the alkalinity and the relation of sulphate thereto, the concentration of phosphate, and the amount of total solids, must be watched carefully. Continuous blowdown and steam washing by feed water, or equivalent, are essential in the case of treated make-up, and provision therefor is desirable when the make-up is evaporated.

In the case of evaporated make-up water, treatment of the feed water for the evaporator may or may not be desirable. If the raw water is contaminated with organic nitrogen or ammonia, either the evaporator brine must not be alkaline, or the nitrogen compound must be removed before the water enters the evaporator. In other cases, treatment by the zeolite or the lime-soda process is optional and in line with economy of operation, but if the evaporator operates under pressure, final treatment of the evaporator brine is best accomplished by phosphate.

In the case of large percentage of make-up water in the feed water, the flexibility of coagulation and the attendant elimination of organic materials, and of treatment with lime and soda ash to obtain desired pH value and limitation of silica and alumina as well as hardness, gives treatment by these methods the preference over others.

Finally, the characteristics of the boiler itself have much bearing on obtaining uninterrupted operation at high pressures whether the feed water is treated water

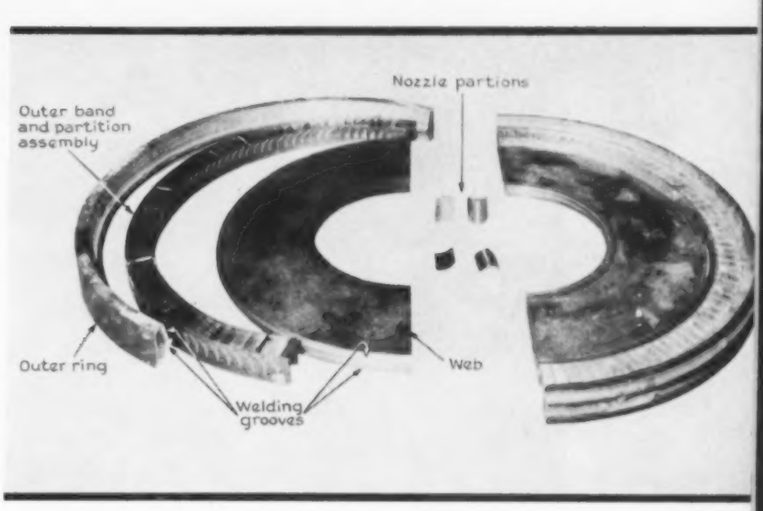
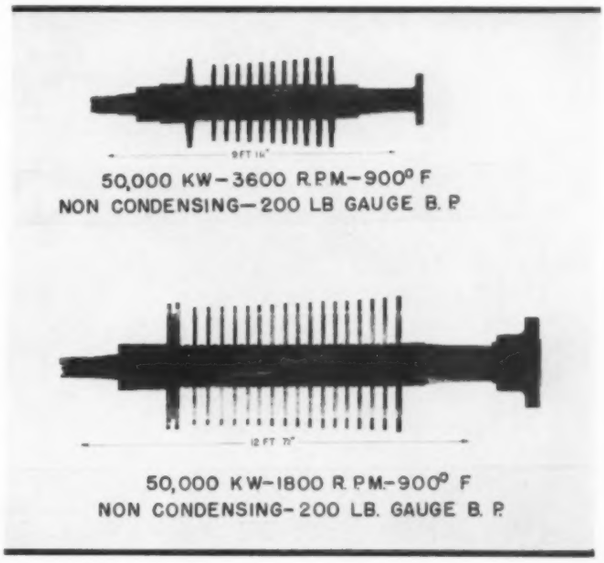


Figure 7—Welded parts used in complicated assemblies.

or evaporated. Not particularly any especial type of boiler, reference is rather made to the highways which the steam travels from evaporative surfaces to steam drum, and whether their capacity is sufficient for quick relief of the evaporative tubes whatever the load. If not, then the surfaces are deprived of the steady flow of water which is their safety, and either the hard insulating sodium-aluminum-silicate type of scale may form or—what is worse—steam and tube will combine with formation of iron oxide as a corrosion product, and eventually such a tube will fail. Removal of chance for any bottlenecks in the passage of steam to the steam drum keeps these steam highways clear, and lets the circulating boiler water contact the evaporative tubes throughout as it should. And then again, for the sudden changes in load to which the industrial boiler is subject, it is advantageous if a considerable reservoir of boiler water is in the boiler to help meet these changing demands somewhat as an accumulator would do, and thus lessen the terrific load which is

Figure 8—Comparison of 3600 and 1800 R.P.M. turbine rotors



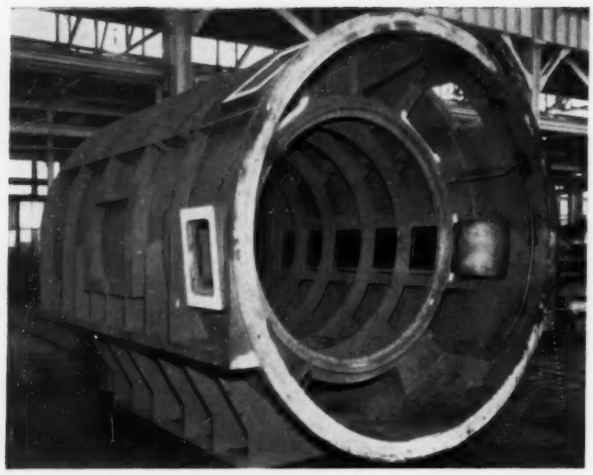


Figure 9—Stationary-armature frame, under construction with fin-tube water cooler in place, for a 31,250 K.V.A., 3600 R.P.M. generator.

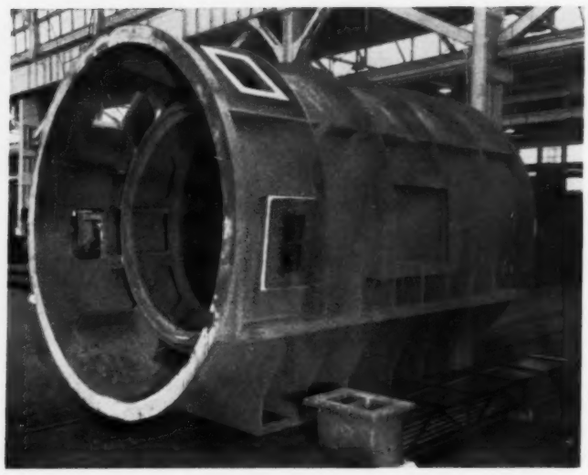


Figure 10—Side view of same generator shown in Figure 9, showing an additional water cooler at side of frame.

placed on the evaporative surfaces if they must furnish entirely the suddenly increased demand.

Where these many factors are coordinated, either high operating pressure or high percentage of make-up represents no particular difficulty. As proof, we cite the plant at Weirton, where at 900 lbs. pressure and with 100% make-up of lime-soda treated water, no difficulties whatever from water have been experienced, and the boiler surfaces are in splendid shape both as regards cleanliness and any tendency for corrosion. Since such results can be attained with 100% make-up, it follows that equally good or better results are a certainty with less treated make-up, or evaporated make-up, provided, of course, that the various factors of water conditioning are given appropriate attention.

For those plants using low fusing ash coal, the intermittent or more recently developed continuously tapped slag removal arrangements offer a release from either more expensive fuel or difficulties attendant with dry ash removal. Slag screens shade the boiler tubes from direct radiation of the flame, and tend to increase the temperature in the combustion zone in order to facilitate the removal of molten slag and increase the recovery of ash in the furnace.

High pressure piping has been successfully developed from carbon-molybdenum seamless steel. With wall thicknesses of ¾ inch and more for 6-inch sizes and larger, expansion and bending become problems of importance. Recent practice has been to weld all joints, including valves and fittings, except those at the superheater and at the turbine throttle. Figure 11 (Sarlun fitting flange 1350 lbs. standard) shows a method in fairly general use for making a flange which will reduce leaks to a minimum.

The engineering background necessary to appreciate and to solve the problems of the modern plant has given rise to the employment of higher grade supervision and operating labor. Almost exclusive of the turbine, as one part of the entire plant, the successful as well as the economic operation of the balance depends on the ability of the personnel to achieve the expected results. Men capable of executing their assignments successfully should naturally receive higher compensation than those the last generation obtained for similar positions.

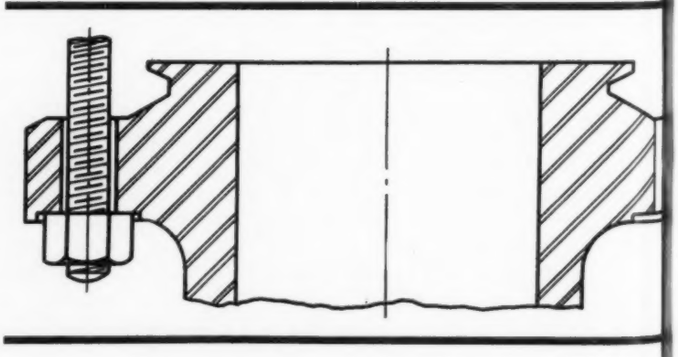
Figure 12 (Relative Heat Consumption of 100,000 Kw. Condensing Steam Turbine Generator Plants) has been drawn to illustrate the gains in heat economy by the use of higher temperature and pressure conditions. Between 400-lb. 750° and 600-lb. 825° there is a possible economy of 6.7%, while an increase to 1200-lb. 825°F. gives a 10% total increased economy.

The industrial plant has the problem in greater or less degree of supplying heat energy in addition to electric power. This gives such a plant an advantage in selection of replacement or added capacity. Several alternatives are open, some of which are:

moderate pressure boilers capable of supplying steam for electric power and for mechanical uses, processes and building heat at generated pressures or throttled to desired pressure. Where the heat requirements are at a sufficient heat-recovery distance from the generated pressure, non-condensing or extraction turbines are a possible solution.

Higher pressure boilers and higher temperature superheaters to take advantage of the widened heat recovery area and of the gains to be made

Figure 11—Sarlun fitting flange—1350-lb. standard.



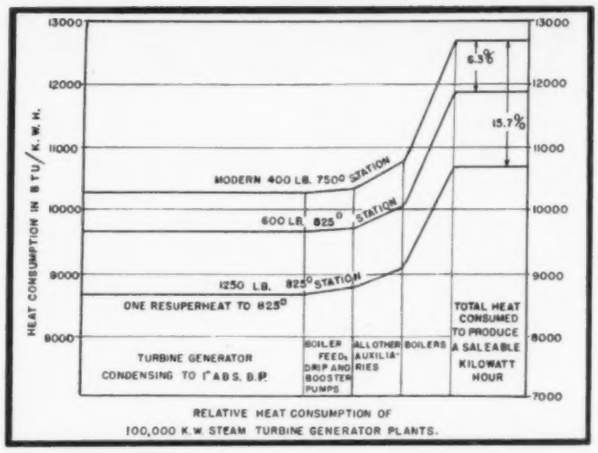


Figure 12—Relative heat consumption of 100,000 K.W. steam turbine generator plants.

in feed water heating economy with straight condensing turbines, extraction-condensing, compound condensing turbines with cross-over pressures suitable for steam tapoff for heat purposes, or non-condensing turbines of proper size to pass steam required for lower pressure existing turbines and/or for steam required for heat.

Where additional firm power is required, the several methods suggested can all be applied. Where additional firm steam supply is demanded without additional power, the choice is limited to taking the steam direct from the boilers or through the medium of a turbine-generator as a reducing valve and decreasing the power generated by condensing turbines accordingly.

Usually an increase in one service is accompanied by an increase in the other service, which allows a number of alternatives to meet the conditions. To-day, while we still vividly recall the disadvantages of overinvestment in times of stress, and while we dislike to discard servicable equipment even though its efficiency or output has somewhat diminished, the attractive features of high-pressure non-condensing turbine-generators and accompanying equipment have been adopted by many plants, including those which are wholly or partly steel manufacturers.

Much has been written on this subject so it is sufficient to summarize some of the advantages. The plan of the non-condensing superposed turbine:—

1. Utilizes existing facilities for fuel handling, condensing water supply, general electrical switching and distribution. It may utilize or may have to add to present building and foundation structures. It does not add to and may reduce the number of attendants.

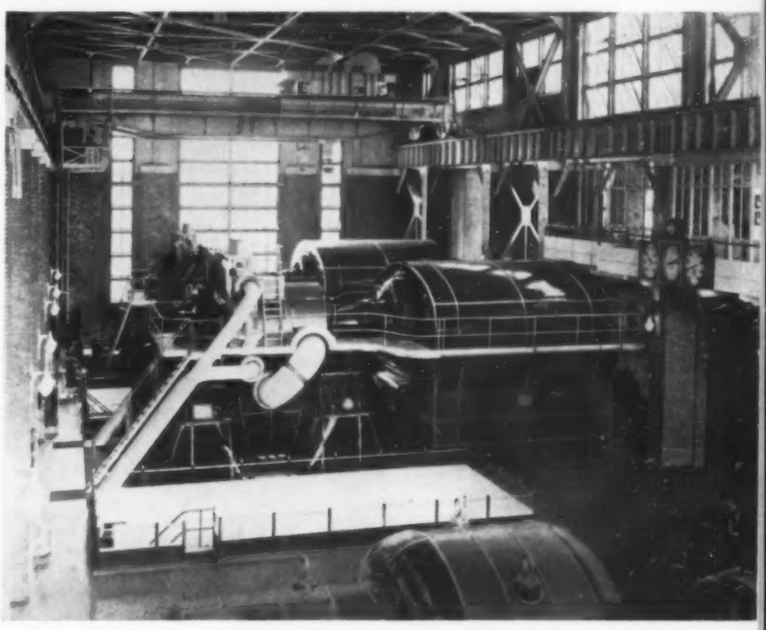
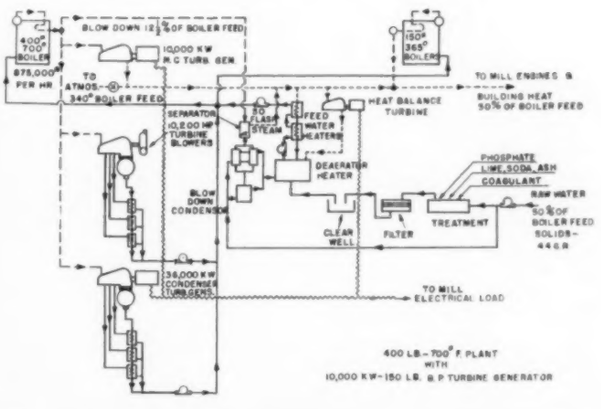


Figure 14—Two vertical-compound steam turbine-generator sets, 110,000 K.W. in power station of Ford Motor Company, River Rouge, Michigan.

Figure 13—Diagrammatic sketch of 400-lb.—700° F. plant with 10,000 K.W.—150-lb. B.P. turbine generator.



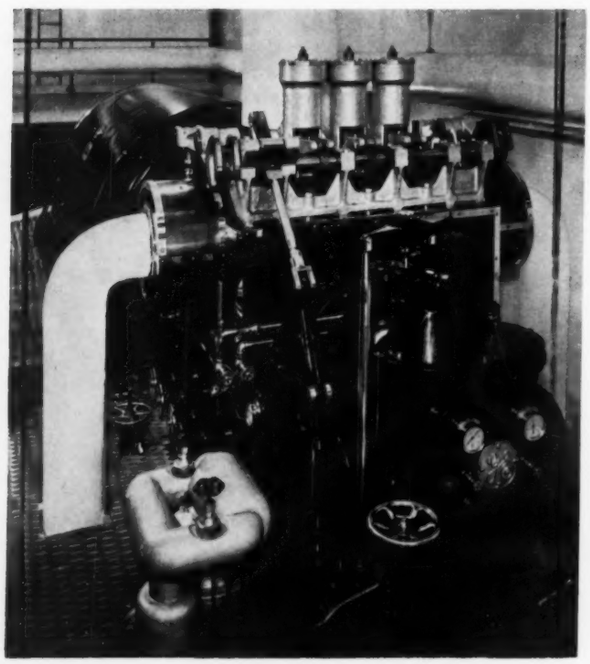
2. It may add to station capacity in smaller increments than may be thought justifiable for condensing units.
3. It makes possible the start of or the extension to a double frequency system—e.g. a non-condensing 60-cycle unit exhausting into the existing mains, furnishing steam to 25-cycle plant, can be accomplished so long as there is sufficient sustained demand for the steam exhausting from the superposed unit.
4. It provides a means of reducing station power costs, which reduction increases as the steam exhausted increases over that required for condensing power generation. Properly apportioned, the amount of heat chargeable to power is the smaller portion of the total cost. Consequently, the overall cost of steam for heat is also reduced.
5. The investment should be no more than for a condensing plant of equal output and may be about 25% less.

So much for the progress in the development of materials and in the science of recovering heat energy. Most convincing are the cases of actual installations and the results which have been attained. There are many to choose from in other industries, but those which are of most interest to the steel industry are the ones which have been installed in that type of plant.

In a few weeks time, a 7500 Kw. non-condensing turbine will be running in a steel plant which already has two 18,000 Kw. condensing turbines and three 3400 H.P. turbine blowers getting their supply of steam from 400-lb. per sq. in., 700°F. total temperature boilers having an output of 875,000 lb. per hour. The schematic arrangement is shown in Fig. 13. Some power is purchased from a utility. Additional steam is generated at 150 lb. per sq. in. for engines, building heat and so forth. The new 7500 Kw. turbine will take steam at 400 lb., 700° and exhaust into the 150 lb. header, so taking the place of other ways of obtaining this steam. The power so generated will reduce the power purchased from the utility. As the fuels used are largely by-products of the mill, the cost of power will be very low. The expected economy of the new unit can be expressed in any one of several ways. For example, by charging $2.40 a ton of coal as the equivalent of the heat in the by-products fuels, a conservative estimate of the fuel saving is $75,000 a year for the same amount of steam as is now used and for the same total power generated as at present. Or, by maintaining the same amount of fuel to the boilers and same heat to the mill, 5600 Kw. over that now generated can be obtained from the new unit and its heat system.

To those who are concerned with feed water that is not suitable for use in high-pressure boilers, this case is extremely interesting. Practically 20,000,000 lb. of feed water are used every day and the makeup is treated

Figure 15—Steam turbine recently installed in Rouge Plant of the Ford Motor Co.



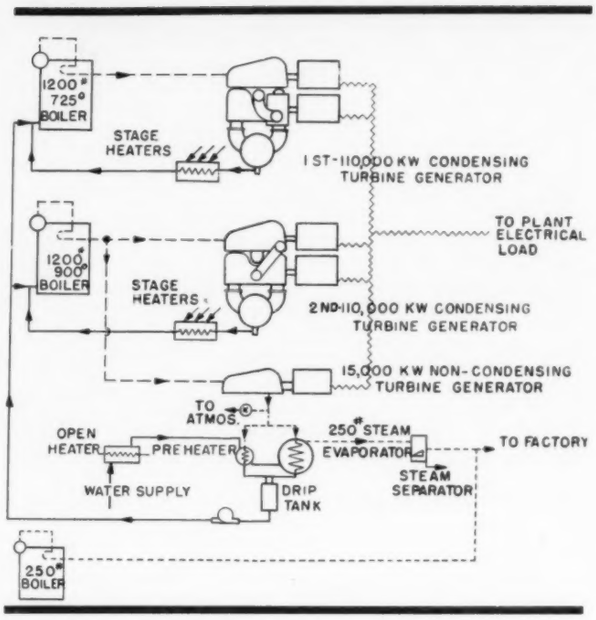


Figure 16—General power plant arrangement, Ford Motor Company

by chemicals so successfully that, in a period of six months since the treatment was started, there has been no deposit found in the boilers, superheaters or turbines. Raw water is pumped to settling tanks where lime, soda ash and coagulant of copper sulphate are added. At this point, where the temperature is whatever occurs in the river, the water is passed through filter tanks. Phosphate is added in the clear well, and the treated water goes on to a deaerator heater where it is joined with the exhaust of a 1500 Kw., non-condensing, 150-lb. pressure turbine used to maintain the desired temperature of feed water and with the drip from two higher temperature heaters. When the installation is completed the treated water will form 50% of the total flow to the boilers. From the deaerator a pump forces the water through two stage heaters supplied with steam from the 150-lb., 365° header. No further heating takes place as the temperature of the feed water has reached 340°.

Starting with 40 grains of solids in the river water, the feed water is treated to a concentration of 42 grains before entering the boilers. This treatment is being carried on for a labor and chemicals charge of 5¾ mills per 1000-lb.

The entire installation, which does not include any boilers or other new equipment, except that for the turbine, some piping changes and switchgear, will, it is expected, cost not more than $50.00 per kw.

Figures 14 and 15 shows the turbines installed in the Rouge Plant of the Ford Motor Company in the last few years. Figure 16 gives the schematic arrangement of the plant.

When the Ford Motor Company—also a producer of steel—decided to modernize their 1928 power plant, they installed a 1400-lb., 750°F. steam generator and the first 110,000 Kw. vertical compound, re-superheating, condensing turbine generator. (Steam conditions at turbine throttle 1200-lb., 725°F. T. T.)

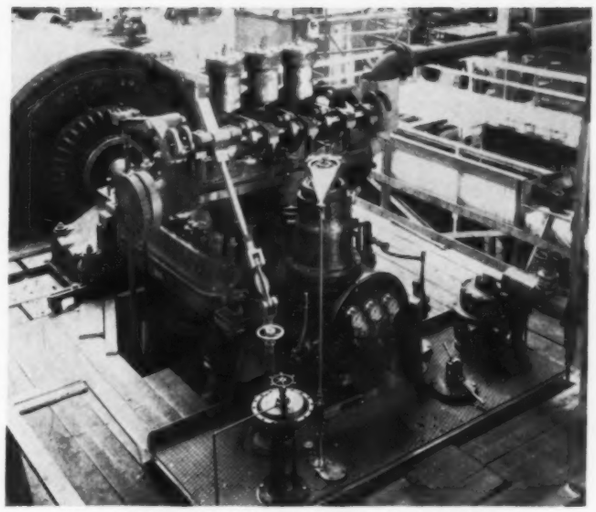


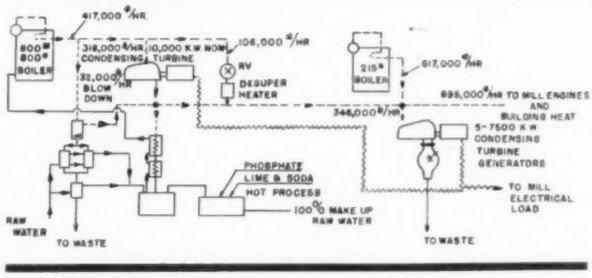
Figure 17—Steam turbine-generator set, 10,000 K.W., 3600 R.P.M., 10 stage.

This year, the second 110,000 Kw., vertical compound, non-resuperheating, condensing turbine generator went into operation at 1200-lb., 900°F. total temperature, the new steam generating unit for this turbine generator being designed for 1400-lb., 925°F. total temperature. Along with it went a 15,000 Kw. non-condensing turbine. The latter exhausts into evaporators against a pressure of 250 lb. This produces vapor at 180 lb., is used along with the output of the older low pressure boilers for plant use and for power in case it is necessary to operate the 30,000 Kw., 250 lb. condensing turbines. Make-up steam for the 2—110,000 Kw. units is also obtained from these evaporators. This plant reports no troubles from deposits in boilers, superheaters or turbines. The non-condensing turbine installation has more than met the results expected from it.

Fig. 17 shows the 10,000 Kw. non-condensing superposed unit installed at the Weirton Steel Co. plant. Fig. 18 is a schematic arrangement of the plant.

About two years ago, the Weirton Steel Company began an investigation of the most suitable way to obtain more power. There were many complications to be met. Due consideration of many practical ways resulted in their deciding to install a 10,000 Kw., 3600 Rpm. non-condensing turbine to exhaust into their existing mill header and to take steam from high pressure boilers. Two new 850-lb., 840° steam generators were installed for the first turbine, with the idea of adding a third duplicate unit when the second turbine was required. Each steam generator has a normal rating of 315,000 lb. per hour, which is sufficient to supply the 10,000 Kw. turbine. Two boilers are normally kept in operation. The steam generating plant was located some distance from the turbine room as this location adapted itself into the general plan, although it meant a rather long run of high pressure piping.

Figure 18—Diagrammatic sketch of 10,000 K.W. superposed turbine-generator in use at the Weirton Steel Company.



The turbine is provided with both back pressure and speed governors so that it may operate to tend to hold constant exhaust pressure with variable electrical load or constant electrical load with fluctuations in 225-lb. pressure being taken by the older low pressure boilers. The latter method of control is now in use and the maximum returns are being realized inasmuch as the widely fluctuating demands for 225-lb. steam would cause a very low load factor on the high pressure turbine. Incidentally, the axiom that the high unit cost equipment should be run at the best possible load factor is being carried out with marked savings in this case.

The low pressure turbines operate condensing with barometric condensers, and the balance of 67% of 225-lb. steam goes to different mills and to feed water heating so that 100% of boiler feed water is obtained from treated raw river water.

The feed heating system incorporates a hot process treatment for the raw water, raising its temperature to 210°. A deaerating heating adds to 218° and the feed water heater brings the temperature to 240°. Lime and soda are introduced in a tank continuously and phosphate intermittently at 210° temperature of raw water. No economizer is used. Sufficient time is allowed to permit the proper admixture of the chemicals before they enter the boilers. The cost of the treatment materials amounts to ½c per 1000 lb. of water.

About 10% of the total high pressure boiler output is blown down to clear the steam to the superheater of a portion of solids. Of this, some 19% is flashed off at 225-lb., the balance going to the raw and feed water heat exchangers and after heaters to raise feed temperature to 278°. The condensate is wasted.

After six months of operation (as of early November), at load factors closely approaching 100% of generator Kw. rating, this plant reports no signs of scale or impingement in the boilers or superheaters, no replacements due to water impurities and no decrease in turbine efficiency.

Boiler and furnace efficiency is 85%. The turbine meets its guaranteed water rates and has carried 94.6% of rated load in K.W.H. per month, with 24-hour averages of 10,820 Kw. and peaks of 13,800 Kw.

The cost per K.W.H. is found to be 70% of the cost of generating the same power in the condensing plant. Some 13,000 tons of coal have been saved in a two-month period and, by operating the high instead of low pressure boilers, a reduction of two boiler attendants has been made.

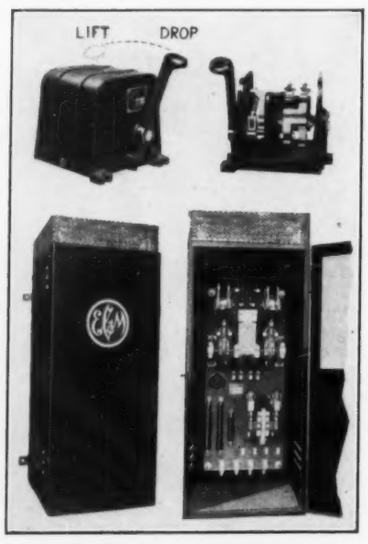
Acknowledgment is made by the author for the courtesy in supplying the information outlined herein regarding steam generators, superheaters, etc., on the part of the Babcock & Wilcox Co. and the Combustion Engineering Co., also on the part of the Hall Laboratories, Inc., for the information regarding feed water treatment.

AUTOMATIC DISCHARGE MAGNET CONTROLLER

▲ FOR providing a quick, clean release of the load on a magnet (all sizes and all types of magnets) The Electric Controller & Mfg. Company, 2695 E. 79th St., Cleveland, Ohio, announce the new EC&M quickly-adjustable, automatic-discharge magnet controller.

This magnet controller uses a small 2-position master switch with positions marked "lift" and "drop", the quick release of the load being obtained by plugging the magnet with the proper value of current in the reverse direction and then the magnet is disconnected from the line automatically as the load is released.

Automatic discharge magnet controller with two-position master switch.



The outstanding feature of this new magnet controller is that it is possible to vary the value of plugging current which is allowed to flow. This permits the operator to adjust the controller at the start of operations to give a fast, clean release. If the line voltage changes or he switches to a different class of material or uses a different size of magnet, a slight turn of the rheostat-dial on this new controller provides the proper plugging current for a quick drop under the new conditions. It is not necessary for the operator to touch the rheostat-dial again unless there is some change in operating conditions of line voltage, type of material handled or size of magnet used. This is a very simple adjustment and is as easy to make as turning the dial on a radio.

A new type of wound-on-edge discharge resistors, which are coated with vitreous enamel, are mounted in a ventilated enclosure on top of the cabinet. The small rheostat-dial for adjusting the dropping out of the reverse-current contactor is shown on the left hand side of the panel which contains the heavy duty, mill type contactors used on this new controller. The entire unit is completely new and has been made compact and narrow for minimum mounting requirements in the rear or side of the crane cab.

The controller is designed for use with any single lifting magnet up to 65 inch in diameter. A similar controller but with more resistance capacity is also available for use with two or more magnets.

INLAND STEEL SETS NEW TONNAGE RECORD

▲ THE Inland Steel Company, well known for its efficient production, has chalked up a new record since resuming operations July 1st. The 76-inch Hot Strip Mill Crew produced 1,677 tons in an eight-hour shift.

Inland's 13,000 men came back to put the mill in capacity operation again with a remarkable spirit of pride of workmanship.

To accomplish such records, it was pointed out, requires not only good equipment and co-ordination of all departments, but also a morale among workers that is stimulated by the recognition of good working conditions and fair play.

The new record came as a reassuring aftermath following an unfortunate and unnecessary strike which had kept the plant closed for a month.

EXTENSIVE ADDITIONS AT GREAT LAKES

▲ COMPLETION of extensive additions now in progress at the plant of its Detroit subsidiary, Great Lakes Steel Corporation, will almost triple the ingot capacity with which National Steel Corporation started when it was organized in 1929, it is announced by Ernest T. Weir, Chairman. The expanded plant will be in operation before the end of this year by which time National's annual ingot capacity will have climbed to 3,400,000 tons from 1,200,000 tons in 1929.

The record of National Steel Corporation is regarded by steel analysts as one of the most spectacular achieve-

ments in industrial history because:

1. It was accomplished during the greatest depression ever experienced in the United States.

2. The company has multiplied its original capacity by three and has financed much of its growth out of earnings.

3. It has earned a profit in every month since its organization.

4. It has never failed to pay a dividend.

With the new Great Lakes capacity, National Steel will have forged ahead to fifth place among the nearly 200 companies that comprise the American Steel industry.

Expansion of finishing equipment, raw material resources and transportation facilities has paralleled the increase in primary steel capacity, and the whole development has been accomplished by a virtually continuous program of additions and improvements at the Great Lakes Steel Corporation, Weirton Steel Company and other National operations.

Although noted as the largest independent producer of tinplate and also as a producer of sheets, strip and other light steels, National Steel Corporation produces a wide range of products that covers almost every staple need of steel consumers. The only major commodities not produced are pipe and wire and the company states that it can enter these markets with but slight rearrangement of facilities any time such a step is required to maintain National's competitive position.

The present program at Great Lakes is one of the most extensive undertaken by the company and will be completed at a cost of more than $25,000,000.

Some of the larger individual projects now being constructed in the expansion program include a new blast furnace, which will be among the largest in the world, coke ovens, open hearth furnaces, annealing furnaces, a slabbing mill, gas mains and a gas holder, an ore bridge, and extension of the present ore docks.

The new blast furnace will have a capacity of 1,000 tons of pig iron per day. It will be 100 feet high and will have a 25-foot hearth and 28-foot bosh. The furnace has been designed to permit enlargement when desired and auxiliary facilities have been arranged so that two additional furnaces of the same size may be included in the installation at some future time. Two furnaces of smaller size comprise the present blast furnace department.

The four 200-ton open-hearths now being constructed will represent a 33⅓ per cent increase in Great Lakes open-hearth capacity. The new furnaces are being built so that they may be increased to duplicate the present 12-furnace installation. The 130 coke ovens under construction will have a capacity of 2,550 tons of total coke every 24 hours.

The slabbing mill reduces ingots to slabs which are the raw material for the 96-inch continuous hot and cold strip sheet mill that went into operation at Great Lakes last year and was the first mill in the world which could roll sheets and strip up to 90 inches in width. The slabbing mill is being built in line with the 96-inch mill and is so arranged that sheets, strip, or plate may be rolled direct from the ingot without reheating.

New annealing furnaces are being built which will increase annealing capacity by 50 per cent. This addition requires extension of the present annealing furnace building.

The installation for the utilization of gas includes a holder which will be 170 feet high and 118 feet in diameter and a 42-inch main almost three miles long. The coke ovens will be fired with gas from the blast furnaces. Excess blast furnace gas and the coke oven gas will be delivered through the mains to be used throughout the Great Lakes operations including slab and billet reheating, and open hearth, box annealing, and normalizing furnace heating. The gas production will be approximately 83,000,000 cubic feet per day.

The dock extension will provide space for the storage of the additional iron ore and coal required by operation of the new blast furnace and the coke ovens. Ore and coal are brought directly to the Great Lakes plant by National's fleet of eight large lake freighters. Iron ore is mined from extensive reserves by Hanna Iron Ore Company, another National Steel subsidiary.

The design of the blast furnace, coke ovens, and open hearth furnaces to permit the enlargement of the facilities themselves or the efficient installation of additional facilities is in line with a policy followed by National Steel Corporation throughout its expansion programs. Last year at Weirton Steel Company improvements of existing equipment made possible a 25 per cent increase in strip steel and tin plate production. In addition to provisions for expansion of existing plants National holds in reserve a site for an entirely new plant in the Chicago district.

OIL OPERATED TYPE PRESSURE CONTROL

▲ THE Hagan Corporation—pioneer in the field of combustion control—has made an important contribution to the art of accurate, sensitive, stable and reliable combustion control in the development of its oil-operated diaphragm type regulators for control of pressures and flows and for the wide range accurate proportioning of air to gaseous and liquid fuels.

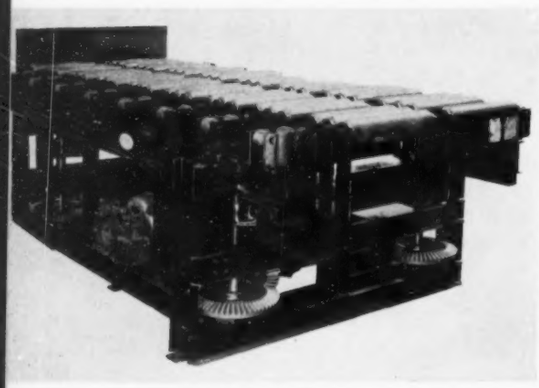
Large numbers of these regulators are in use in many of the leading steel mills on open hearth furnaces, slab and billet heating furnaces, and on the four principal types of new soaking pits which have been installed recently. These Hagan oil-operated diaphragm regulators have established a sound reputation for simplicity, sensitivity, stability, and reliability.

Oil-operated diaphragm type regulator for the control of pressures and flows.

SHEET STACK TRANSFER CONVEYER

▲ SHOWN below is the 14 ft. long Sheet Stack Transfer Conveyer, recently developed for a southern strip mill. The unit is designed to receive stacks of sheets and discharge them at right angles onto a processing line conveyer. The stacks handled weigh approximately 20,000 lbs. The largest individual sheet is 72″ wide by 13′ long.

The operation of the mechanism is somewhat unique. A line of heavy duty roller conveyer receives the stacks from overhead crane, and they move lengthwise by gravity onto two parallel roller conveyer lines mounted on the transfer mechanism. As a stack comes to rest against the bumper of the transfer, the unit is placed in operation. The two parallel lines of conveyer are lowered a distance of 4½ inches, depositing the stack on eight parallel lines of roller conveyer which are set at a slight grade and carry the stack off at 90° in relation to the direction in which it was traveling when received. The illustration shows the transfer in the receive position with the two parallel lines of receive conveyer up.



Sheet stack transfer conveyor, 14 feet long, recently developed for a southern strip mill.

When the discharge operation is accomplished, the receive conveyer is immediately raised into place ready to receive the next stack of sheets. Having been discharged from the transfer, the individual sheets are subject to end and side shearing operations and conveyed to a piling unit.

The raising and lowering of the transfer conveyer is accomplished by means of bevel gears placed at each of the four corners of the table. These gears are connected to screw shafts. A 15 H. P. motor with speed reducer connection actuates drive shafts and pinions which in turn operate the bevel gears and screw shafts, the operation of the latter actually raising and lowering the conveyer section.

The receive conveyer, which is the two parallel lines subject to raising and lowering, is "stake type" roller conveyer, commonly used where sheet packs are loaded or unloaded by overhead cranes. The discharge conveyor lines incorporate short rollers mounted in heavy angle frames. The unit is all welded and heavily built throughout in order to withstand the severe service to which it will be subject.

FIFTY CRANES FOR NEW IRVIN WORKS

▲ ORDERS for 50 overhead traveling cranes for installation at Irvin Works have been let by Carnegie-Illinois Steel Corporation.

The orders were divided among the following concerns: Harnischfeger Sales Corp., Milwaukee, Wis.; Cleveland Crane and Engineering Co., Cleveland, O.; Alliance Machine Co., Alliance, O.; and Shaw-Box Crane and Hoist Co., Muskegon, Mich.

These cranes, comprising one of the largest group installations in the history of the steel industry, vary in capacity from five to 60 tons, and spans vary from 60 feet to 120 feet.

Additional cranes of individual type for special purposes at Edgar Thomson Works, Braddock, Pa., will be supplied by the Morgan Engineering Co., and the Alliance Machine Co., both of Alliance, O.

Four of these cranes, of 250 tons capacity and among the largest ever built, will be ladle cranes for use at Edgar Thomson. Two will be 200-ton cranes for stripping ingot molds.

In addition, certain electrical equipment, including a considerable number of the motors to operate the big new sheet, strip and tin plate plant, has been ordered from the General Electric Co., Schenectady, N. Y.,; Westinghouse Electric & Manufacturing Co., Pittsburgh, and Allis-Chalmers, Inc., Milwaukee. The plant will have an installed electric motor horsepower of 300,000 upon completion.

The Amsler-Morton Co., of Pittsburgh, has been given an order for 16 soaking pit furnaces to be installed at Edgar Thomson Works for operation in connection with the slabbing mill which will supply Irvin Works with raw material. Each pit furnace will have a capacity of six to eight slab ingots varying in weight from 10 to 17 tons each.

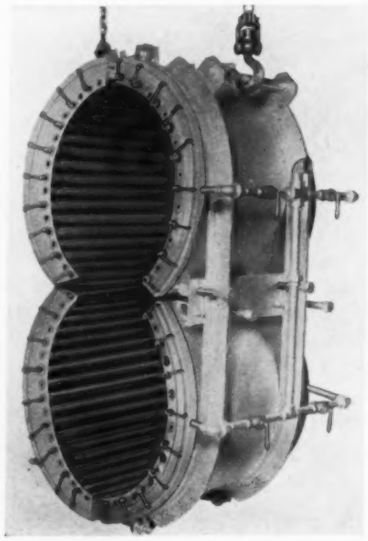
USE OF RADIANT HEAT ON HOT MILL ROLLS

▲ A recent development of The C. M. Kemp Mfg. Co., brings to the preheating of hot mill rolls a highly efficient radiant heat application, the use of which is becoming prevalent for many heating operations.

The principle of radiant tube heating as applied to roll heating follows the work which the Kemp Co. has done in extending the use of gas fuel to what are generally considered the more refined heating applications, particularly those where in the past it has been felt necessary to use comparatively high cost electric resistance heating to obtain temperature distribution, low gradient, and control. Examples of this are Kemp immersion heaters for the melting of non-ferrous metals and Kemp radiant tube recirculating radiators as used in annealing furnaces.

The radiatube roll heater is designed to conform to the contour of the rolls being heated. All heat is transferred by radiation from the heat resisting tubes which are internally heated by specially designed burners supplied with complete air-gas mixture under positive pressure from a Kemp industrial carburetor.

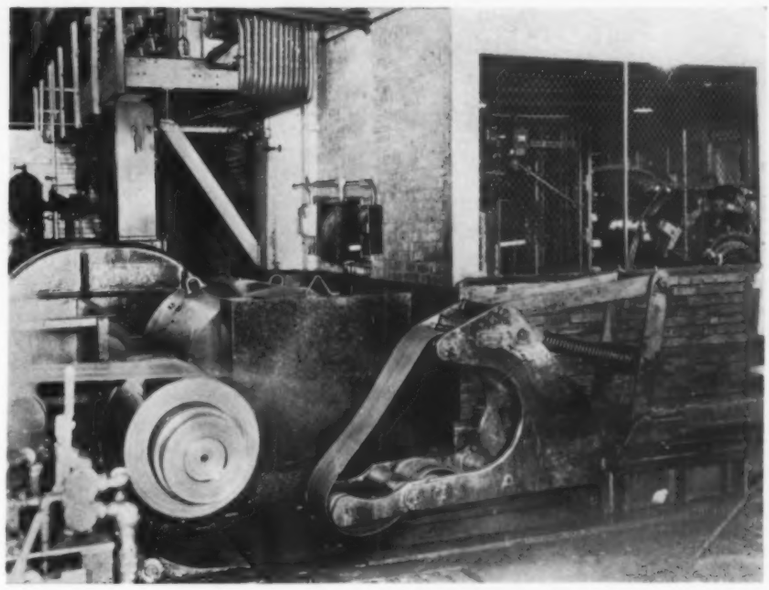
Radiatube roll heater for hot mill rolls.



By using this method a high velocity flame, burning to complete combustion regardless of tube temperature, is secured. A multiplicity of tubes fired alternately from opposite ends provides adequate heat transfer surface to give high thermal efficiency. The unit is backed up with several inches of high grade insulation and mounted in a heavy steel supporting frame with adjustments provided to fit the unit closely to the pair of rolls.

Initial installations show operating efficiencies that will permit replacement of electric heat with a saving of approximately 90% to the average user.

The equipment is built by The C. M. Kemp Mfg. Co. under license arrangement covering existing patents as well as under patent applications which have been assigned to the Kemp Company.



Tension reel belt-wrapper withdrawn after the strip has been threaded onto the reel.

BELT WRAPPER FOR COLD STRIP MILLS

▲ AMONG the many successful developments of the United Engineering and Foundry Company, has been the United Belt Wrapper for heavier gages of cold reduced strip. A total of twelve of these tin plate units have been shipped and eight are now in regular production. Tonnage has been stepped up about 15% in each case and as such the unit has paid for itself in a matter of days or weeks after its installation.

This increased tonnage is obtained through the elimination of the necessity to slow down or stop the mill in order to enter the leading end of the strip in the reel gripper. The belt wrapper takes the strip from the mill at threading speed and automatically wraps the leading end around the reel and establishes the tension.

When the coil has been rolled and the reel head collapsed, there is no end sticking in the gripper to catch and hinder the stripping operation and the reel head can be rotated backward to further aid this process of stripping.

The success of the units for tin plate gauges caused the further development for wider mills and for heavier strip. Three of these larger units were ordered and two have recently been shipped.

REHEATING FURNACES FOR IRVIN WORKS

▲ RUST Furnace Company has been awarded the contract for three slab heating furnaces for the Irvin Works. Each furnace will have a capacity to heat 60 gross tons of slabs an hour, raising them from cold to rolling temperatures of 2,300 degrees F. The furnaces will burn coke oven gas and will be supplied complete with platforms, stacks, stack flues, and automatic central equipment. They will cost about $500,000.

THREE NEW STEEL PLANTS FOR GERMANY

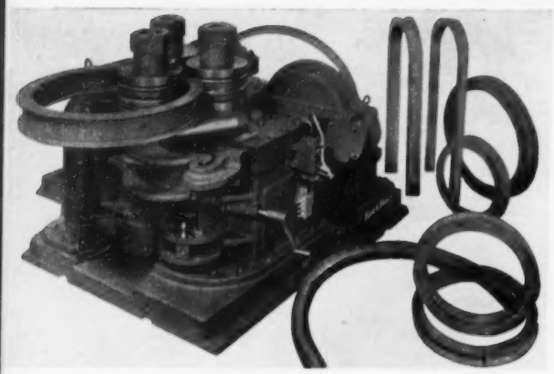
▲ THE Berlin Branch of H. A. Brassert & Company has been awarded the contract by the German Government to build and put into operation three complete new iron and steel works. These works will be located on the native ore deposits, and will be located one plant in North Germany near Brunswick, one in Bavaria and one in Baden. These plants are being built in accordance with the Government's program to increase the use of native resources.

The first plant will be of very large capacity. All three plants will use the new basic Bessemer process as developed in recent years at the Corby iron and steel plant, which was built by Mr. Brassert for Stewarts and Lloyds, Ltd. The new plants will include ore mining plants and development, ore preparation, coke ovens, blast furnaces, steel works and rolling mills.

HORIZONTAL ANGLE BENDING ROLL

▲ KANE & ROACH, INC., of Syracuse, New York, has recently offered to the trade, a new improved type Horizontal (vertical shaft) Angle Bending Roll. This machine, while primarily set up to bend angles in a horizontal plane, is also suitable for bending I-Beams, rails, channels, flats, squares, tees, octagons, hexagons, Z-bars, rounds, pipe, tubing, special shapes, etc.

The front roll can be adjusted in and out for pressure adjustment, to vary the diameter of the circles. Generally, this adjustment, is accomplished by manual operation of the adjusting screw, but the machine can be furnished, as illustrated, with power drive to the "pressure adjustable" roll shaft. A quick release is provided on the latch lock, and the "pressure adjustable" roll shaft can



Improved type horizontal, vertical shaft, angle bending roll.

be quickly swung open, to remove bent sections from the roll passes.

Of particular interest is the high quality of bend obtainable on this machine, when bending angles leg in, the design being such as to provide an edge bearing on the vertical leg of the angle, thereby relieving the excessive strain on the horizontal leg, and distributing the bending stress between the horizontal and vertical legs of the angle.

In addition, the edge bearing taper plates are tapered, so that the legs of the angle remain square (at 90°), and the horizontal leg remains parallel to a straight edge laid across the face of the circle.

Plates of this type can be furnished for all size angles, and are required only when bending angles, leg in, to small diameters. The machine illustrated is provided with Farval one-shot lubricating system. The machine has a production of approximately 18 to 27 ft. per minute, but can be operated at considerably higher speed on light sections, up to 50 to 75 ft. per minute, is obtainable. The particular machine illustrated is known as their No. 23, and has a capacity of 5 x 5 x ½″ angles, leg out, 4½ x 4½ x ½″ angles, leg in, and proportionate shapes.

The main drive motor on the machine illustrated is 30 HP, DC shunt wound rotor motor, variable speed, 1150-1725 RPM, and a separate 15 HP motor is provided for the power adjusting screw. Both motors are directly connected to reduction gear boxes, these gear boxes being of the enclosed type, with all gears running in oil, and equipped with Timken Anti-friction Bearings.

FABRICATION OF NEW DRAWHEAD

▲ THE mine car department of a prominent Steel Corporation recently saved itself considerable delay by fabricating a locomotive drawhead instead of waiting for replacement for a cast steel head which failed in service. The drawhead which failed is illustrated in Figure 1, while Figure 2 shows the new drawhead fabricated by electric welding.

The new drawhead shown in Figure 2 was fabricated by cutting up standard steel shapes and plate to correct size, assembling them in their proper position and fusing all of the parts together into a single piece of steel by the electric arc. In order to provide maximum strength, the welding was done in two beads.

"Fleetweld" electrodes manufactured by The Lincoln Electric Company, Cleveland, Ohio, were used. The setting up of the various parts and the welding was done in approximately 16 hours. This represents a considerable savings in time over waiting for a cast steel part to replace the one which was broken.

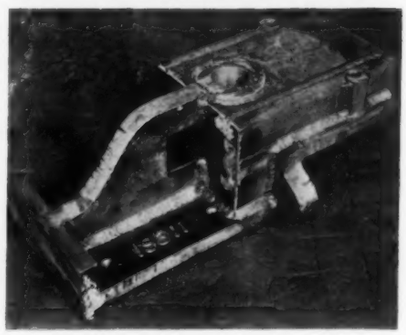


Figure 1 Above.—Figure 2 Below.

SOUTHERN TIN MILL NEARS COMPLETION

▲ CONSTRUCTION is progressing on the new tin plate project by the Tennessee Coal, Iron & Railroad Company, subsidiary of United States Steel Corporation, in Birmingham. When completed, the huge project will employ 2,500 men and have an annual capacity of 200,000 gross tons of finished tin plate, giving Steel's southern subsidiary a back-log during seasonal business variations. Serving the South, Pacific Coast, and Hawaii, the new mills will be an inducement for tin product manufacturers to locate in the South. With 65% of excavation completed, 30% of concrete poured, 55% structural steel fabricated, and 48% erected, construction of the new project is progressing rapidly with assurance of completion on schedule early next year. The five buildings will house the shearing units, the north cold reduction room, the tempering mills and cold reduction mills, the south cold reduction room, the annealing department.

Construction view of new tin plate mill of the Tennessee Coal Iron & Railroad Co., Birmingham, Ala.

ITEMS OF INTEREST

Leon Stephens was transferred from the Gary Tin Mills, Carnegie-Illinois Steel Corporation, to the Tennessee Coal Iron and Railroad Company, at Birmingham, Alabama, to be the superintendent of the hot strip mill of that plant. Mr. Stephens first employment in Gary was at Gary Works as assistant roller from November 1926 to October 1927. At that time he was transferred to the Gary Tin Mill, first as roller on the 42″ hot strip mill and then as assistant foreman of the same mill. Later he was transferred to the Gary Sheet Mill as turn foreman on the 80″ hot strip mill, the position he has held up to the present time.

▲

Howard C. Kaeff, formerly turn foreman of the 42-inch hot strip mills at the Gary Sheet and Tin mills of Carnegie-Illinois Steel Corporation, has been appointed superintendent of the cold reduction mills of the Tennessee Coal, Iron and Railroad Company at Birmingham, Alabama.

Mr. Kaeff was first employed at the Gary Sheet mill on October 24, 1916 as assistant order clerk, a position he held until 1926, when he left the corporation. He was re-employed two years later as cutting-up shear foreman and after serving in that capacity until 1935 was transferred to the cold reduction department. A year later he was transferred to the 42-inch hot strip mills as turn foreman and held that position until his recent promotion.

▲

Harold F. Ingram was placed in charge of the order department of the tin plate division of the Tennessee Coal, Iron and Railroad Company at Birmingham, Alabama.

Mr. Ingram has been connected with United States Steel Corporation subsidiaries since 1923. Born in Wheeling, West Virginia, he began his work in the steel industry in 1918, as a production clerk for the Wheeling Steel and Iron Company. After service with the Wells Hardware Company as a clerk, and with the Wheeling Steel Corporation as a storekeeper, he came to the La Belle Works of the American Sheet and Tin Plate Company as assistant order clerk in January 1923, remaining there until 1927. Since October 1927 he has been with the Gary tin mill in the capacities of a clerk in the 42″ mill, tracer in the order department, and as assistant chief inspector his present position.

▲

Roman J. Myer was made the roughing mill slab yard foreman for the 42″ hot strip mill of the Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama. Mr. Myer started at the Gary Tin Mills in January 1927. His varied experience has included work as a laborer, craneman, timekeeper, machinist's helper and weighmaster.

▲

Samuel B. Webster has been appointed chief engineer of Vandergrift Works, Carnegie-Illinois Steel Corporation, succeeding William A. Marshall who was recently appointed superintendent of construction of the Irvin Works.

Mr. Webster began his engineering career as a draftsman with the Carnegie Steel Company in 1908 and three years later joined the American Bridge Company at Brooklyn, New York. Following service with other firms, Mr. Webster entered the United States Army in 1917 and served in the 28th Division until July 1919. Mr. Webster returned to Carnegie Steel Company in 1921 as a draftsman in the general offices and in 1930 was promoted to the position of special engineer, serving continuously until his recent appointment.

▲

W. H. Stewart has been made superintendent of the roll department for the Homestead Works,

LEON STEPHENS

HOWARD C. KAEFF

HAROLD F. INGRAM

ROMAN J. MEYER

Carnegie-Illinois Steel Corporation, succeeding Mr. Harold P. Ingram, who was made the superintendent of maintenance.

Mr. Stewart was graduated from University of Pittsburgh as a mechanical engineer in 1928. He entered the employ of American Steel and Wire Company at Driscoll, Pennsylvania, the same year, and in 1929 transferred to the wire company's Worcester, Massachusetts plant. He came to Homestead as roll designer in September 1929, and continued in that capacity until his recent appointment.

▲

Harold P. Ingram was made superintendent of maintenance at the Homestead Works of the Carnegie-Illinois Steel Corporation. In his new position Mr. Ingram will supervise the electrical and mechanical maintenance and the roll department.

Mr. Ingram began his business career in the engineering department at the East Pittsburgh plant of Westinghouse Electric and Manufacturing Company in 1913. He entered the Homestead Works as an apprentice roll turner in 1915. In 1920, following study at Carnegie Institute of Technology, he became roll draftsman and in 1928 was named superintendent of the roll department.

▲

O. E. Romig was appointed assistant research engineer of the Research Laboratory, Pittsburgh District, Carnegie-Illinois Steel Corporation.

Mr. Romig formerly was a contact representative in the sheet and strip division of the metallurgical department, dealing particularly with silicon steel organization in 1924 in the Research Laboratory of the American Sheet and Tin Company. He was manager of the electrical sheet division at the time American Sheet and Tin Plate Company joined the Carnegie-Illinois Steel Corporation in June 1936.

▲

J. Murray Lenhart has been assigned to special metallurgical duties in the Pittsburgh District offices of the Carnegie-Illinois Steel Corporation, a position for which his long years of experience have given him valuable training. The exacting requirements of the new position made it desirable to select Mr. Lenhart, who has an unusual knowledge of the special types of products produced at Duquesne Works.

Mr. Lenhart's career with the company began almost forty years ago, on October 1, 1897, when he entered the old City Mills Company, as a testing engineer. After ten years there he was transferred for the period from June 1, 1907 until June 1, 1908, to the Sharon, Pennsylvania, plant of Carnegie Steel Company as chief inspector. He then was made chief inspector of Duquesne Works of the Carnegie-Illinois Steel Corporation, which position he held until his present appointment.

▲

John R. Anderson, formerly metallurgical contact man for the Cleveland-Buffalo District of the Carnegie-Illinois Steel Corporation, has been made chief inspector of the Duquesne Works of the same company.

Mr. Anderson graduated from Lehigh University in 1931 as an metallurgical engineer. He went with the United States Steel Corporation the same year, as a research assistant in the Kearny, New Jersey, laboratories. Mr. Anderson was later associated with the American Steel and Wire Company in Worcester, Massachusetts, but left in 1935 for a year, returning to Carnegie-Illinois in 1936.

▲

W. R. Duda, formerly chief engineer of Mackintosh Hemphill Co., has been appointed chief engineer of Continental Roll and Steel Foundry Co.

Mr. Duda started in the steel business with the U. S. Steel Corp. in Pittsburgh and later became associated with the United Engineering and Foundry

W. R. DUDA

Co. with which concern he remained until his enlistment in the Ordnance Corps during the World War. Shortly after his return, he became associated with the Mackintosh Hemphill Co. where he served in equipment sales and engineering capacities for the past eighteen years.

▲

G. F. Ahlbrandt and **W. W. Lewis** have been appointed as assistant vice presidents of The American Rolling Mill Company and H. M. Richards has been appointed manager of the sheet and strip sales division in several important changes in the Armco Sales Division announced by W. W. Sebald, vice president in charge of commercial activities for the company. These changes are due to the company's enlarged business, the announcement said.

Mr. Ahlbrandt joined the Armco organization in 1904 as an open hearth chemist. He later became assistant open hearth superintendent and in 1909 entered sales work for the company, ultimately becoming general manager of sales.

Mr. Lewis came to Armco in 1917 as assistant open hearth superintendent. In 1922 he took up sales work and in 1925 was made manager of the London branch of Armco International Corporation. Returning to Armco sales headquarters in 1927, he was appointed assistant to the vice president in charge of commercial activities.

Mr. Richards joined Armco in 1913 as a clerk in the order department, later becoming assistant man-

ager in that department. In 1916 he was made a salesman and in 1924 was appointed district manager of Armco's Cleveland, Ohio, office, where he remained until 1931, when he was appointed assistant general manager of sales.

▲

Ralph K. Clifford, formerly general superintendent of the Continental Steel Corporation, has just been appointed works manager of Continental's Kokomo plant.

▲

Julian L. Schueler, formerly superintendent of the Steel and Wire Division of the Continental Steel Corporation, has been named general superintendent.

▲

Neal J. Crain has been appointed purchasing agent of United Engineering & Foundry Company, Pittsburgh. Mr. Crain was formerly assistant to G. Walter Sanborn, who continues as vice president in charge of purchases and traffic. Mr. Crain has been with United Engineering and Foundry Company for over twenty years, except for a period during the World War.

▲

G. W. Hoskins, recently with Lincoln Electric Company, has joined the Harnischfeger Corporation of Milwaukee as sales engineer for smootharc welder and weld rods in the P & H Philadelphia territory. Widely acquainted with men interested in the technical side as well as the merchandising of welder and weld rods in this territory, Mr. Hoskins has, in addition to his six years experience with the Lincoln Electric Company, also worked as welding inspector on 100 miles of 8″ pipe line for the Sun Oil Company. Previous to this time he worked as a welder operator on tank construction for six months in Charleston, W. Va. His practical experience also includes several months in general shipyard welding on the east coast.

▲

H. Lee Reynolds has been appointed by the Automatic Transportation Company as the representative in the Pittsburgh district to succeed the late Malcolm M. Nesbit. Associated with Mr. Reynolds will be L. N. Crissman formerly of the Exide Battery Company.

▲

Ernest C. Bartell, Tarentum, Pa., has been appointed personnel director of the West Leechburg division of Allegheny Steel Co., Brackenridge, Pa. Mr. Bartell attended Princeton university, graduating in 1927, and taking two years in post-graduate work. In 1929 he joined the faculty and athletic coaching staff of Phillip-Exeter academy, Exeter, N. H., from which position he joins Allegheny.

▲

Dr. A. Allan Bates recently joined the staff of Westinghouse Research Laboratories as manager of the chemical and metallurgical division. Dr. Bates formerly was professor of metallurgy at Case School of Applied Science and served as consultant for a number of companies in the Cleveland area. Previously he was employed by the National Tube Co., and was also research metallurgist for the National Malleable & Steel Casting Co.

Dr. Bates was graduated from Ohio Wesleyn in 1923. He then attended Case School and received a B. S. in metallurgy. From 1930 to 1931 he attended the Ecole De Metallurgie, University of Nancy, France, from which he received his degree of Doctor of Science in metallurgy.

▲

Died

George E. Stimple, president of the Stimple and Ward Company, electrical service firm, died July 24, in his home, 1950 Perrysville Avenue. A lifelong

GEORGE E. STIMPLE

resident of Pittsburgh, he had been engaged in the electrical business for more than fifteen years.

Mr. Stimple had long been an active and popular member of the Association.

▲

R. R. Huggins, Jr., sales manager and vice-president of the Thermal Products Corp., Pittsburgh, died recently in that city at the age of 32 years. Mr. Huggins attended Shadyside Academy and the University of Pittsburgh. Shortly after leaving the latter school he became associated with the Standard Sanitary Mfg. Co. at Washington. He later entered the employ of the Campbell-Huggins Donat Co. and the Thermal Products Corp., both of Pittsburgh, which connections he maintained up to the time of his death.

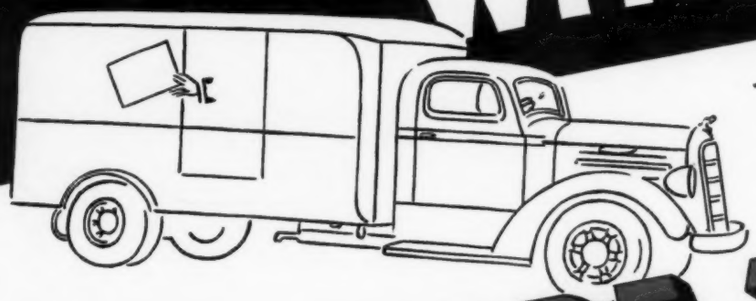
▲

John H. Smith, 52, president and treasurer, American Steel Engineering Co., Philadelphia, July 25. He bagan his career with Twin City Rapid Transit Co. and later was manager at Dallas, Tex., for many years for Truscon Steel Co. He formed American Steel Engineering Co. in 1919.

▲

David J. Scott, 56, chief clerk, bar and strip production bureau, Carnegie-Illinois Steel Corp., Pittsburgh, Aug. 3. He was an employe of that corporation, and its predecessors 38 years, starting in 1899 with the American Steel Hoop Co. His business activities for many years involved handling the distribution and scheduling of material.

. . . from 2 to 3 *Needless* BLOWS PER WEEK TO NONE — IS OUR RECORD WITH —



FUSES MADE TO

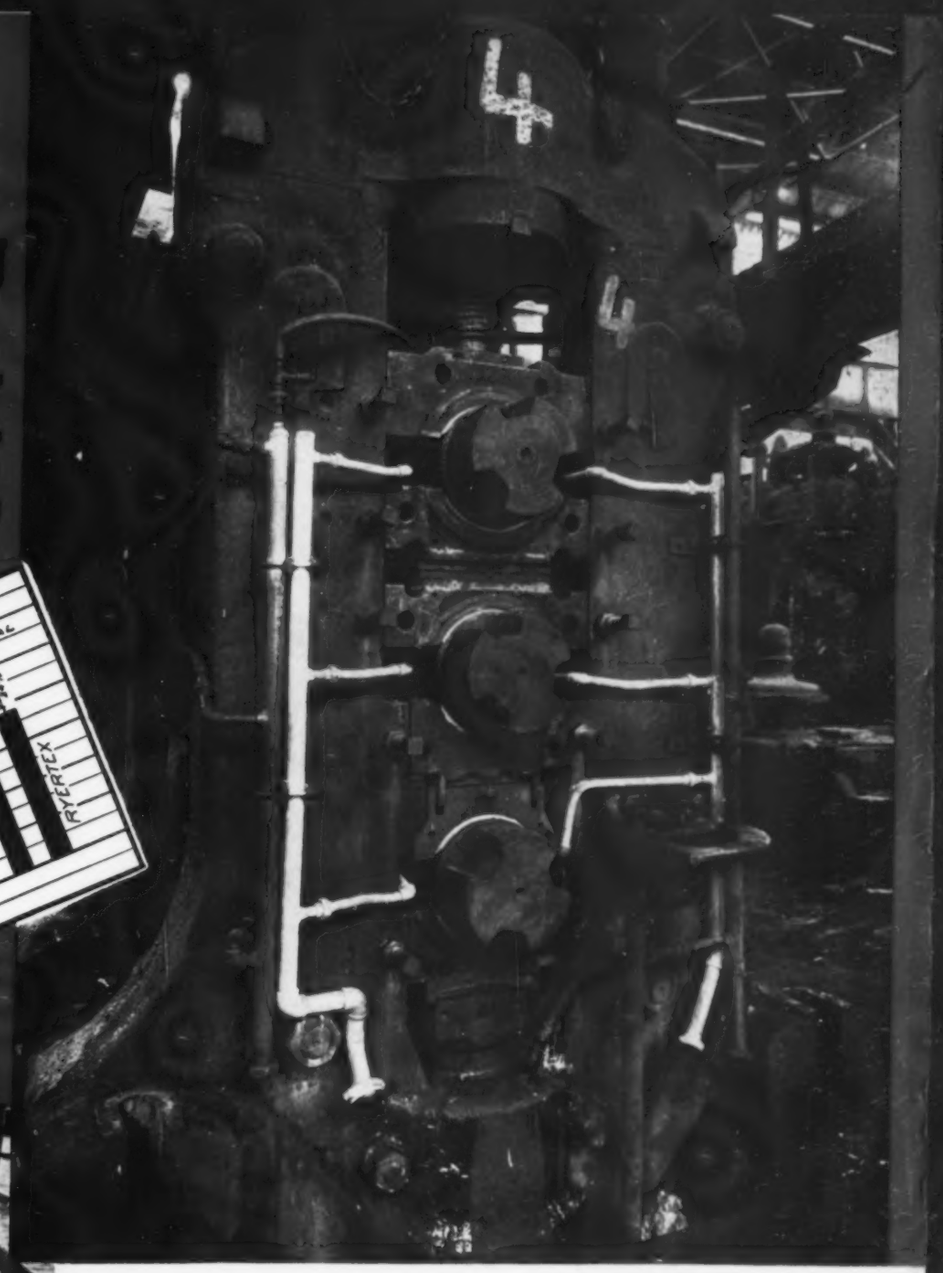
SAYS Mr. R. Ranger, Electrical Engineer of International Motor Co., New Brunswick, N. J.

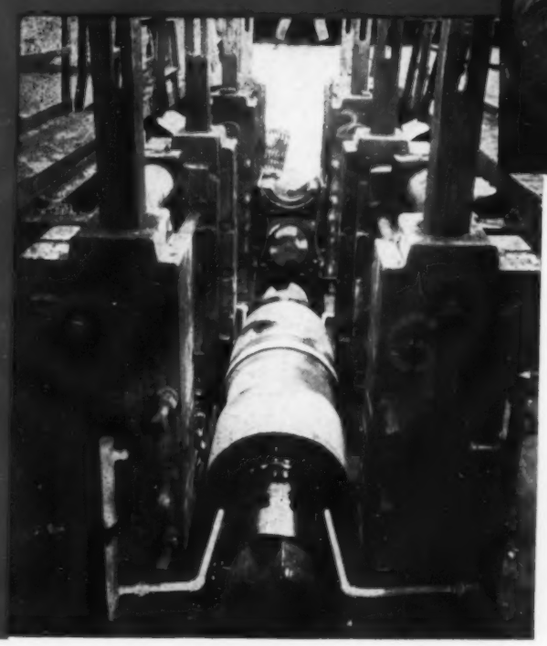
"60 ampere 600 volt fuses are used to protect a motor which drives a line shaft that operates drill presses and grinders. Overloading of these machines was causing two to three fuse blows per week.

"In March 1933 we installed BUSS Super-Lag fuses. Since then we have not had a single shutdown caused by the blowing of a fuse."

28⅔% Power Saving with RYERTEX BEARINGS

1. Based on 100 pilings compared, Babbitt and Ryertex on the same sections.





2. Installing the Bearings and water pipes for lubricating them.

28" 3-Stand 3-High Structural and Rail Mill

Sections Rolled—I-Beams, 7" to 24"—Channels, 10" to 15"—Angles, 6" x 3½" to 8" x 8"—Standard Rails, 80 to 131 lbs.—Sheet Piling, 8½" to 19⅝" wide from straight webb to 6" deep arch—Rounds—Squares—Tie Plates—Splice Bars.

This mill has been completely equipped with Ryertex Bearings since June, 1934. The Ryertex Bearings have given 7 to 8 times longer service than the babbitt they replaced. Other facts on this installation are—

Average power saving—28⅔% (See Chart).

Complete elimination of grease.

Increased speed under load and less adjustment of rolls has resulted in maintaining steadier sections and better deliveries.

Only slightly more water used than on babbitt bearings.

Condition of roll necks greatly improved showing a much smoother surface than on babbitt bearings.

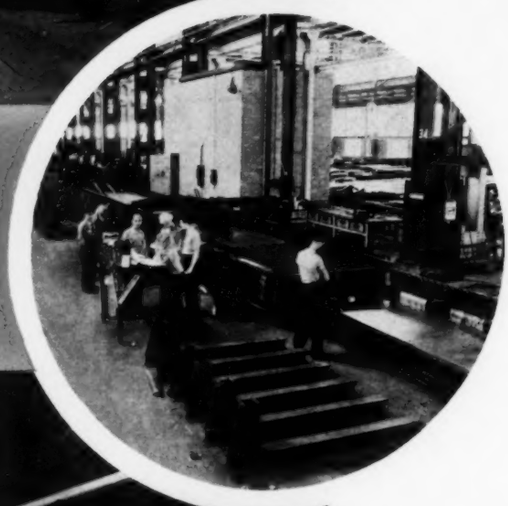
Due to eliminating grease on rolls, much cleaner and safer mill.

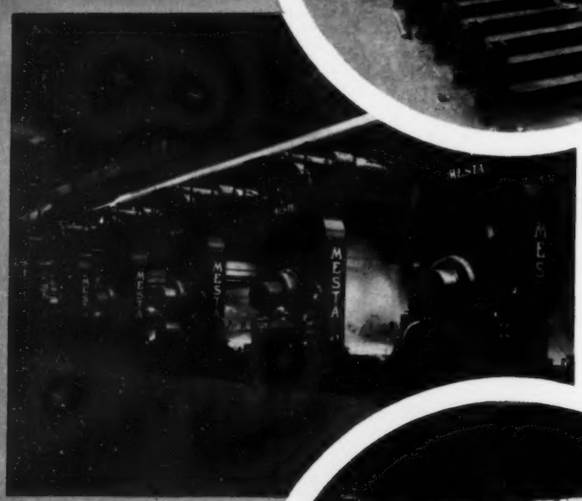
Ryertex Bearings are giving similar results on all types of mills. We will be glad to give you complete performance data on any type of installation in which you are interested.

JOSEPH T. RYERSON & SON, INC., Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON STEEL-SERVICE

"600,000 tons, annual capacity. Mathews Conveyers in Sheet processing line shown at the right."





"336,000 tons, annual capacity. Mathews Conveyers handling coils of sheet steel shown at the right."

10,000,000 T
OF FLAT RO

BEING exponents of The Continuous Flow Principle of Handling Materials, we are proud to have been associated so intimately with the extensive technological improvement in the Steel Industry, which in the past seven years has added 10,000,000 tons capacity of flat rolled steel products.

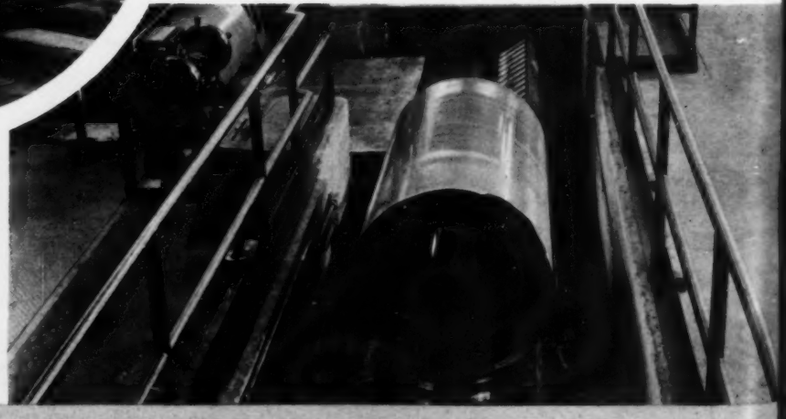
In the long run in any competitive economy, the size of the market for any product depends upon price, and price depends upon cost of production. This policy and marketing strategy ultimately depend upon how efficiently production is organized, and the future of any business considered as a financial problem is equally determined by its ability to solve production problems.

Organizing of production as a unitary process is, then, the primary function of general management.

Somewhere in every successful. expanding business somebody must constantly visualize production as a whole and supply the coordinating thinking required to keep the productive process one of continuous flow.

If this principle of production is accepted as the basic principle, and if the argument is also

"Directly below and at the lower left, illustrations show handling of Coils in the vertical and horizontal position."



MATHEWS CONVEYER C

TONS

ROLLED STEEL

accepted that materials handling methods are the backbone of efficiently organized modern production, the selection of materials handling equipment is then, a matter of general executive policy.

In the past, department heads and engineers of the industry have shown initiative, cooperating in order to obtain installations of materials handling equipment incorporating the Continuous Flow Principle.

Today, this principle is entering a new phase. Its magnitude as a basic principle is recognized in the design and building of entire mills. In their respective fields completely modern plants based upon the Continuous Flow Principle will set the pace.

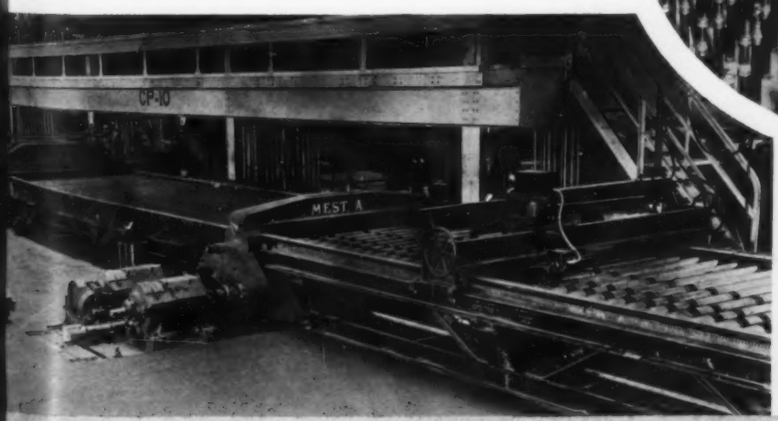
Our new book which summarizes installations of processing equipment installed during the past twenty-four months contains over one-hundred pages and is written for both operating and engineering personnel.

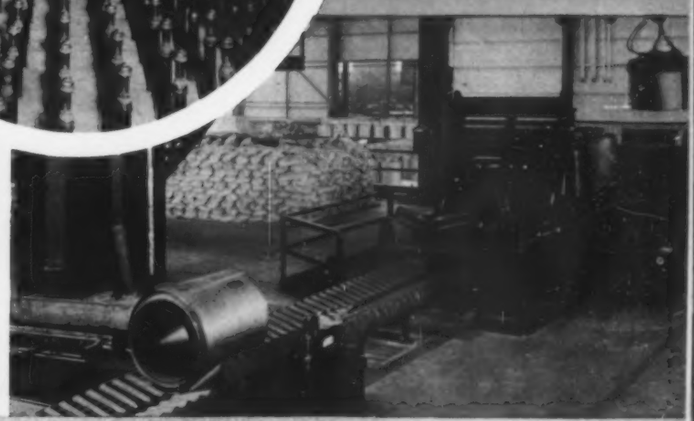
Executives of the Steel Industry are requested to ask for the book "EQUIPPING THE STEEL INDUSTRY FOR CONTINUOUS PRODUCTION". Write to the Mathews Conveyer Company, 144 Tenth Street, Ellwood City, Pennsylvania.

"300,000 tons, annual capacity. A Mathews Conveyer System handling coils from storage to processing machinery."

"320,000 tons, annual capacity. Mathews Ball Transfers handling plates from run-out table to shears."

"Below. Processing Conveyers with gauger table in foreground. Lower right. Coil upender and tilting tables."





R COMPANY • ELLWOOD CITY, PENNA.